File No. I/159/2019-ME

# Autonomous

Universities of Punjab

PTU-DEPT

Dept of Mechanical Engineering

SUBJECT

| | | |
|---|---|---|
| **Main Category** | **:** | Boards Of Studies |
| **Sub Category** | **:** | Meetings |
| **Description** | **:** | Proceedings of the Board of Studies (Physical Sciences), IKGPTU University Campus meeting held on 04.07.2019. |

OTHER DETAILS

| | | |
|---|---|---|
| **Retention** | **:** | |
| **Priority** | **:** | |
| **Language** | **:** | English |
| **Confidentiality** | **:** | |
| **Remarks** | **:** | |

No correspondence is attached in this file.

**Note No. #1**

A meeting of members of Board of Studies (Physical Sciences), IKGPTU University Campus was held on 04.07.2019 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala. The agenda of the meeting was discussed in detail and recommendations were made on point. The proceedings of the meetings were recorded in the minutes of the meeting as enclosed as an Annexure.

Submitted for necessary action.

**MoM BoS 04 07 2019.pdf**

**19/07/2019 10:33 AM**

**NEETIKA**
**(AP(PHYSICAL SCIENCES))**

IKGPTU/PS/4001
11/07/2019.

# I.K. Gujral Punjab Technical University, Kapurthala

## Department of Physical Sciences

### Minutes of Meeting

A meeting of members of Board of Studies (BoS)-Physical Sciences, IKGPTU University Campus was held on 04.07.2019 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala.

**Following members of BOS and special invitees were present and actively participated in discussion:**

1. Dr. Amit Sarin (Chairperson)
2. Dr Rakesh Dogra, Member
3. Dr N. S. Saini, Member
4. Dr. B. C. Chaudhary, Member
5. Dr. H. M. Mittal, Member
6. Dr. Harleen Dahiya, Member
7. Dr. Hitesh Sharma, Member
8. Dr. Maninder Kaur, Member
9. S. Navdeepak Sandhu, Member
10. Dr. Ashish Arora, (Special invitee)
11. Dr. Neetika (coordinator)
12. Ms Manu Rani, Alumni representative
13. Mr. Puneet, M.Sc. (2nd Year) -Student representative

The following members could not attend the meeting:

1. Dr Arvinder Singh, Member
2. Dr D. P. Singh, Member
3. Dr. Bivash Behra, Member
4. Dr. Ashok Kumar, member
5. Dr Varinderjit Singh, Member
6. Dr. Sarabjit Singh Mann, (Special invitee)
7. Dr. Chander Parkash, (Special invitee)
8. Dr. Priyanka Mahajan, (Special invitee)

The Board of Studies discussed on all the agenda points and following recommendations were made:

**Agenda item 1: To consider the Vision and Mission of Department of Physical Sciences with the Program Educational objectives (PEO), Program outcomes (POs), Program specific outcomes (PSOs), and Course outcomes of B.Sc. (Hons.) Physics and M.Sc. (Physics).**

Rakesh Dogra

All BoS members discussed the Program Educational objectives (PEO), Program outcomes (POs), Program specific outcomes (PSOs) of the B.Sc. (Hons.) Physics and M.Sc. (Physics) with the Vision and Mission of Department of Physical Sciences. After incorporating suggestions, BOS members recommended the Program Educational objectives (PEO), Program outcomes (POs), Program specific outcomes (PSOs) and Course outcomes (COs) of various subjects for B.Sc. Hons. (Physics) and M.Sc. (Physics) for approval w.e.f. 2019-2020. **The copy of revised Vision and Mission of Department of Physical Sciences, Program Educational objectives (PEO), Program outcomes (POs), and Program specific outcomes (PSOs) of B.Sc. (Hons) Physics and M.Sc. (Physics) is enclosed as Annexure-I**.

**Agenda item 2: To consider the study scheme and syllabi of B. Sc. (Hons.) Physics for the first two semesters in the academic session 2019-2020**

All BoS members discussed the study scheme and syllabi of B Sc. (Hons.) Physics for 1st and 2nd semester for academic session 2019-2020. Board members agreed that two physics core courses and one lab will be offered in the both first and second semester. Syllabi of the interdisciplinary courses was proposed by their representative and were discussed. The guidelines for the paper setters, internal and external evaluation will be similar to the B.Tech. examination pattern of IKGPTU. BoS members also approved the question paper pattern for the Mid Semester Tests. **The copy of study scheme, syllabi, MST question paper pattern, instructions for paper setters, format of question paper of B.Sc. (Hons.) Physics is attached here as Annexure-II.**

**Agenda item 3: To consider the study scheme and syllabi of M.Sc. (Physics) for the academic session 2019-2020**

All BoS members discussed and recommended the new study scheme and syllabi of M Sc. Physics w.e.f. academic session 2019-2020. **The copy of study scheme, syllabi, MST question paper pattern, instructions for paper setters, format of question paper of M.Sc. Physics is attached here as Annexure-III.**

**Agenda item 4: To consider the adoption of study scheme and syllabi of M.Sc. Physics (3rd and 4th semester) 2018 batch.**

The board members agreed that the study scheme and syllabi of M.Sc. Physics-2018 batch of IKGPTU may be adopted for the 3rd and 4th semester of 2018 batch of Main Campus.

**Agenda item 5: To consider the syllabus of value-added course on Personality Development**

All BoS members discussed the syllabus of inter disciplinary value-added course on Personality Development for M.Sc. Physics students which was proposed by Dr. Priyanka Mahajan. Board members approved the content for implementation and agreed that more interdisciplinary courses on Human values, Management, etc., may be added in near future. **The copy of finalized syllabus of Personality Development is enclosed as Annexure-V.**

**Agenda item 6: To consider the Swayam/MOOC courses as interdisciplinary open electives**

All BoS members recommended that all undergraduate and post graduate students may select courses from Swayam/MOOC as open elective as per relevance to their respective study scheme. The student may be given due credit as per University guidelines.

| | | |
|---|---|---|
| Dr. Amit Sarin | Dr Rakesh Dogra | Dr N S Saini 4/7/19 |
| Dr B C Chaudhary | Dr H M Mittal 4/7/19 | Dr Harleen Dahiya 4/7/19 |
| Dr Hitesh Sharma 04/07/2019 | Dr Maninder Kaur 4/7/2019 | Dr Neetika 4/7/19 |
| Dr Ashish Arora 4/7/2019 | S. Navdeepak Sandhu 04/VII/19 | Ms Manu Rani 4/7/19 |

Mr. Puneet, M.Sc. (Physics)

**Annexure-I**

# IK Gujral Punjab Technical University

## VISION

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the future leaders of technology and techno- innovation responsible for the techno-economic, social, cultural and environmental prosperity of the people of the State of Punjab, the Nation, and the World

## MISSION

- To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to promote research, discovery and entrepreneurship and
- To prepare its students to be responsible citizens of the world and the leaders of technology and techno-innovation of the 21$^{st}$ Century by developing in them the desirable knowledge, skill and attitudes base for the world of work and by instilling in them a culture for seamlessness in all facets of life.

## OBJECTIVES

- To offer globally-relevant, industry-linked, research-focused, technology- enabled seamless education at the graduate, postgraduate and research levels in various areas of engineering & technology and applied sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global technological needs, is motivated to give its best and is committed to the growth of the Nation;
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization;
- To participate in the planning and solving of engineering and managerial problems of relevance to global industry and to society at large by conducting basic and applied research in the areas of technologies;
-

- To develop and conduct continuing education programmes for practicing engineers and managers with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core competence of the University;
- To develop strong collaborative and cooperative links with private and public sector industries and government user departments through various avenues such as undertaking of consultancy projects, conducting of collaborative applied research projects, manpower development programmes in cutting-edge areas of technology, etc;
- To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit;
- To provide leadership in laboratory planning and in the development of instructional resource material in the conventional as well as in the audio-visual, the video and computer-based modes;
- To develop programmes for faculty growth and development both for its own faculty as well as for the faculty of other engineering and technology institutions;
- To anticipate the global technological needs and to plan and prepare to cater to them;
- To interact and participate with the community/society at large with a view to inculcate in them a feel for scientific and technological thought and endeavor; and
- To actively participate in the technological development of the State of Punjab through the undertaking of community development programmes including training and education programmes catering to the needs of the unorganized sector as well as that of the economically and socially weaker sections of society.

## *ACADEMIC PHILOSOPHY*

The philosophy of the education to be imparted at the University is to awaken the **"deepest potential"** of its students as holistic human beings by nurturing qualities of self-confidence, courage, integrity, maturity, versatility of mind as well as a capacity to face the challenges of tomorrow so as to enable them to serve humanity and its highest values in the best possible way.

# DEPARTMENT OF PHYSICAL SCIENCES

## VISION

To be a knowledge nerve center in Physical Sciences, Pure, and Applied Research and Industry requirements for creating sustainable infrastructure and enhancing quality of life of the people of the State of Punjab, the Nation and the World

## MISSION

1. To offer globally-relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate, and research levels in various areas of Physical sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global scientific and technological needs, is motivated to give its best and is committed to the growth of the Nation;

2. To develop and conduct continuing education programs for Science graduates with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core specialization of the University;

3. To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit.

# B.Sc. (Hons) Physics

**PROGRAM EDUCATIONAL OBJECTIVES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PEO1 | Apply principles of basic science concepts in understanding, analysis and prediction of physical phenomenon. |
| PEO2 | Develop human resource with knowledge, abilities and insight in Physics and related fields required for career in academia and industry. |
| PEO3 | Engage in lifelong learning and adapt to changing professional and societal needs. |

**PROGRAM OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PO1 | Apply the knowledge gained to solve the scientific problems. |
| PO2 | Identify, formulate, and analyze scientific problems reaching substantiated conclusions using first principles of mathematical, physical, and chemical sciences. |
| PO3 | Design solutions for physics problems that meet the specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal consideration. |
| PO4 | Use research-based knowledge and methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | Create, select, and apply appropriate techniques, resources, and modern scientific tools to physics problems with an understanding of the limitations. |
| PO6 | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues, and the consequent responsibilities relevant to the professional scientific practice. |
| PO7 | Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | Apply ethical principles and commit to the norms of scientific practice. |
| PO9 | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | Communicate effectively on scientific activities with the Scientific/Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give |

| | |
|---|---|
| | and receive clear instructions. |
| PO11 | Demonstrate knowledge and understanding of the scientific principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO12 | Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change. |

**PROGRAM SPECIFIC OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PSO1 | Understand the concepts in different areas of physics. |
| PSO2 | Demonstrate expertise to conduct wide range of scientific experiments. |
| PSO3 | Apply the concepts of physics in areas of mechanics, electromagnetism, solid state, nuclear, etc., in industry, academia, and day-to-day life. |

# M.Sc. Physics

**PROGRAM EDUCATIONAL OBJECTIVES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PEO1 | Apply principles of basic scientific concepts in understanding, analysis, and prediction of physical phenomenon. |
| PEO2 | Develop human resource with specialization in theoretical and experimental techniques required for career in academia, research, and industry. |
| PEO3 | Engage in lifelong learning and adapt to changing professional and societal needs. |

**PROGRAM OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PO1 | Apply the scientific knowledge to solve the complex physics problems. |
| PO2 | Identify, formulate, and analyze advanced scientific problems reaching substantiated conclusions using first principles of mathematics, physical, and natural sciences. |
| PO3 | Design solutions for advanced scientific problems and design system components or processes that meet the specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal consideration. |
| PO4 | Use research-based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | Create, select, and apply appropriate techniques, resources, and modern scientific tools to complex physics problems with an understanding of the limitations. |
| PO6 | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional scientific practice. |
| PO7 | Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | Apply ethical principles and commit to the norms of scientific practice. |
| PO9 | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | Communicate effectively on scientific activities with the Scientific/Engineering community and with society at large, such as, being able to comprehend and write |

| | |
|---|---|
| | effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | Demonstrate knowledge and understanding of the scientific principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO12 | Recognize the need for,and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change. |

**PROGRAM SPECIFIC OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PSO1 | Understand the basic and advance concepts in different areas of physics. |
| PSO2 | Perform and design experiments in the areas of electronics, atomic, nuclear, condensed matter, and computational physics. |
| PSO3 | Apply the concepts of physics in specialized areas of condensed, nuclear, renewable energies, particle physics, etc., in industry, academia, research and day today life. |

**Annexure-I**

# B.Sc. (Hons.) Physics

## Course Structure and Syllabus

## (Based on Choice Based Credit System)

## 2019 onwards

**PROGRAM EDUCATIONAL OBJECTIVES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PEO1 | Apply principles of basic science concepts in understanding, analysis and prediction of physical systems. |
| PEO2 | Develop human resource with knowledge, abilities and insight in Physics and related fields required for career in academia and industry. |
| PEO3 | Engage in lifelong learning and adapt to changing professional and societal needs. |

**PROGRAM OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PO1 | Apply the knowledge gained to solve the scientific problems. |
| PO2 | Identify, formulate, and analyze scientific problems reaching substantiated conclusions using first principles of mathematical, physical, and chemical sciences. |
| PO3 | Design solutions for physics problems that meet the specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal consideration. |
| PO4 | Use research-based knowledge and methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | Create, select, and apply appropriate techniques, resources, and modern scientific tools to physics problems with an understanding of the limitations. |
| PO6 | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues, and the consequent responsibilities relevant to the professional scientific practice. |
| PO7 | Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | Apply ethical principles and commit to the norms of scientific practice. |
| PO9 | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | Communicate effectively on scientific activities with the Scientific/Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | Demonstrate knowledge and understanding of the scientific principles and apply these to one's own work, as a member and leader in a team, to manage projects and in |

| | |
|---|---|
| | multidisciplinary environments. |
| PO12 | Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change. |

**PROGRAM SPECIFIC OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PSO1 | Understand the concepts of different branches of physics. |
| PSO2 | Demonstrate expertise to conduct wide range of scientific experiments. |
| PSO3 | Apply the concepts of physics in areas of mechanics, electromagnetism, solid state, nuclear, etc., in industry, academia, and day-to-day life. |

**SEMESTER FIRST**

| Course Code | Course Title | Type of course | Load Allocation | | | Marks Distribution | | Total Marks | Cr |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Internal | External | | |
| UC-BSHP-111-19 | Optics | **Core Course Theory and Practical** | 3 | 1 | - | 40 | 60 | 100 | 4 |
| UC-BSHP-112-19 | Electricity and Magnetism | | 3 | 1 | - | 40 | 60 | 100 | 4 |
| UC-BSHP-113-19 | Physics Lab-I | | - | - | 4 | 30 | 20 | 50 | 2 |
| UC-BSHM-XXX-19 | Calculus | **General Elective and Practical** | 3 | 1 | - | 40 | 60 | 100 | 4 |
| UC-BSHC-XXX-19 | Inorganic Chemistry | | 3 | 1 | - | 40 | 60 | 100 | 4 |
| UC-BSHC-XXX-19 | Chemistry Lab-I | | - | - | 4 | 30 | 20 | 50 | 2 |
| UC-BSHX-XXX-19 | Communicative English -I | **Ability Enhancement Compulsory Course** | 2 | - | - | 20 | 30 | 50 | 2 |
| UC-BSHX-XXX-19 | Punjabi Compulsory-I or Mudhli Punjabi-I | | 2 | - | - | 20 | 30 | 50 | 2 |
| **TOTAL** | | | 16 | 4 | 8 | 260 | 340 | 600 | 24 |

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**SEMESTER SECOND**

| Course Code | Course Title | Type of course | Load Allocation | | | Marks Distribution | | Total Marks | Cr |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Internal | External | | |
| UC-BSHP-121-19 | Waves and Vibrations | **Core Course Theory and Practical** | **3** | **1** | **-** | **40** | **60** | **100** | **4** |
| UC-BSHP-122-19 | Mechanics | | **3** | **1** | **-** | **40** | **60** | **100** | **4** |
| UC-BSHP-123-19 | Physics Lab-II | | **-** | **-** | **4** | **30** | **20** | **50** | **2** |
| UC-BSHM-XXX-19 | Mathematics | **General Elective and Practical** | **3** | **1** | **-** | **40** | **60** | **100** | **4** |
| UC-BSHC-XXX-19 | Organic Chemistry | | **3** | **1** | **-** | **40** | **60** | **100** | **4** |
| UC-BSHC-XXX-19 | Chemistry Lab-II | | **-** | **-** | **4** | **30** | **20** | **50** | **2** |
| UC-BSHX-XXX-19 | Communicative English -II | **Ability Enhancement Compulsory Course** | **2** | **-** | **-** | **20** | **30** | **50** | **2** |
| UC-BSHX-XXX-19 | Punjabi Compulsory -II or Mudhli Punjabi-II | | **2** | **-** | **-** | **20** | **30** | **50** | **2** |
| **TOTAL** | | | **16** | **4** | **8** | **260** | **340** | **600** | **24** |

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**Examination and Evaluation**

| **Theory** | | | |
|---|---|---|---|
| **S. No.** | **Evaluation criteria** | **Weightage in Marks** | **Remarks** |
| 1 | Mid term/sessional Tests | 24 | Internal evaluation (40 Marks)<br>MSTs, Quizzes, assignments, attendance, etc., constitute internal evaluation. Average of two mid semester test will be considered for evaluation. |
| 2 | Attendance | 6 | |
| 3 | Assignments | 10 | |
| 4 | End semester examination | 60 | External evaluation |
| 5 | Total | 100 | Marks may be rounded off to nearest integer. |
| **Practical** | | | |
| 1 | Evaluation of practical record/ Viva Voice/Attendance/Seminar/ Presentation | 30 | Internal evaluation |
| 2 | Final Practical Performance + Viva-Voce | 20 | External evaluation |
| 3 | Total | 50 | Marks may be rounded off to nearest integer. |

## Instructions for Paper-Setter in B. Sc (Hons.) Physics

### A. Scope

1. The question papers should be prepared strictly in accordance with the prescribed syllabus and pattern of question paper of the University.

2. The question paper should cover the entire syllabus with proper distribution and Weightage of marks for each question.

3. The language of questions should be simple, direct, and documented clearly and unequivocally so that the candidates may have no difficulty in appreciating the scope and purpose of the questions. The length of the expected answer should be specified as far as possible in the question itself.

4. The distribution of marks to each question/answer should be indicated in the question paper properly.

### B. Type and difficulty level of question papers

1. Questions should be framed in such a way as to test the students intelligent grasp of broad principles and understanding of the applied aspects of the subject. The Weightage of the marks as per the difficulty level of the question paper shall be as follows:

   i) Easy question 30%

   ii) Average questions 50%

   iii) Difficult questions 20%

2. The numerical content of the question paper should be upto 25%.

### C. Format of question paper

1. Paper code and Paper-ID should be mentioned properly.
2. The question paper will consist of three sections: Sections-A, B and C.
3. Section-A is COMPULSORY consisting of TEN SHORT questions carrying two marks each (total 20 marks) covering the entire syllabus.
4. The Section-B consists of FOUR questions of eight marks each covering the entire PART-A of syllabus (Taking two questions from every unit).
5. The Section-C consists of FOUR questions of eight marks each covering the entire PART-B of syllabus (Taking two questions from every unit).
6. Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.

## Question paper pattern for MST:

| **Roll No:** | **No of pages:** |
|---|---|

| **IK Gujral Punjab Technical University- Jalandhar** | |
|---|---|
| **Department of Physical Sciences** | |
| **Academic Session:** | |
| **Mid-Semester Test: I/II/III (Regular/reappear)** | **Date:** |
| **Programme:** B.Sc. (Hons.) Physics | **Semester:** |
| **Course Code:** | **Course:** |
| **Maximum Marks: 24** | **Time: 1 hour 30 minutes** |

❖ Note: Section A is compulsory; Attempt any two questions from Section B and one question from Section C.

| **Section: A** | | **Marks** | **COs** |
|---|---|---|---|
| 1 | | 2 | |
| 2 | | 2 | |
| 3 | | 2 | |
| 4 | | 2 | |
| **Section: B** | | | |
| 5 | | 4 | |
| 6 | | 4 | |
| 7 | | 4 | |
| **Section: C** | | | |
| 8 | | 8 | |
| 9 | | 8 | |

*Details of Course Objectives*

| | |
|---|---|
| *CO1* | |
| *CO2* | |
| *CO3* | |
| *CO4* | |
| *CO5* | |

# SEMESTER-I

| **UC-BSHP-111-19** | **Optics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Physics and Mathematics

**Course Objectives:** The objective of the course is to develop basic understanding of Interference, Diffraction and Polarization among students. The Students also learn about the LASER and its applications. Students will be equipped with knowledge to measure wavelength, refractive index and other related parameters, which will act as a strong background if he/she chooses to pursue physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Identify and illustrate physical concepts and terminology used in optics and other related wave phenomena |
| **CO2** | Analyze and understand coherence and phenomenon of interference and their applications |
| **CO3** | Acquainted with Fresnel's and Fraunhofer's diffraction and their applications. |
| **CO4** | Get thorough knowledge of the polarization of light and its changes upon reflection and transmission, and will learn to analyze the polarization in optical systems. |
| **CO5** | Describe the different types of lasers, its principle, properties of laser beam. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 1 | - | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **CO3** | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |

**Detailed Syllabus:**

***PART-A***

**UNIT I**

**Interference:** Definition and properties of wave front, Temporal and Spatial Coherence, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Newton's Rings: Measurement of wavelength and refractive index, Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, Fabry-Perot interferometer. (11 Lectures)

**UNIT-II**

**Diffraction:** Huygens Principle, Huygens-Fresnel Diffraction theory, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel diffraction pattern of a straight edge and circular aperture. (11 Lectures)

***PART-B***

**UNIT-III**

**Polarization:** Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals, Polarization by Scattering, Polarization by Double Refraction, Nicol Prism, Huygen's theory of Double Refraction, Polaroid, Elliptically and Circularly polarized lights, Quarter and Half wave plates. (11 Lectures)

**UNIT-IV**

**Laser and Application:** Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Einstein relations, Conditions for Laser actions, Population inversion, Different types of Laser Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three and Four level laser systems, Ruby laser, He-Ne gas Laser, Semiconductor laser, CO2 laser, applications of laser: Holography, Principle of Holography.
(11 Lectures)

**Text and Reference Books:**

1. Optics: A.K. Ghatak (Tata-McGraw Hill), 1992.
2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.
3. A Text Book of Optics: Subrahmaniyam N. & et al.(S. Chand Publishing) (2006).
4. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

| **UC-BSHP-112-19** | **Electricity and Magnetism** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Basic knowledge of Electricity and Magnetism at high school level.

**Course Objectives:** The objective of the course is to expose the students to the formal structure of electricity and magnetism so that they can use these as per their requirement.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand and describe the different concepts of electrostatics and magnetostatics |
| **CO2** | Apply the knowledge of Maxwell's equation and flow of electromagnetic waves in real problems. |
| **CO3** | Analyze the wave propagation in different media |
| **CO4** | Compare the different types of polarization |
| **CO5** | have a solid foundation in electromagnetism fundamentals required to solve problems and also to pursue higher studies. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 1 | - | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 1 |
| **CO3** | 3 | 2 | 3 | - | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO4** | 3 | 2 | 3 | 2 | - | 2 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO5** | 2 | 2 | 3 | 2 | - | 2 | 2 | 1 | 1 | 3 | 1 | 1 |

**Detailed Syllabus:**

***PART-A***

**UNIT I**

**Review of Vector Analysis and Electrostatics:** scalar and vector product; gradient, divergence and curl and their significance; Gauss-divergence theorem and Stoke's theorem (statement only); Electrostatic field; electric flux; Gauss's law of electrostatics; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions *(11 Lectures)*

**UNIT-II**

**Magnetostatics:** Magnetic flux; magnetic flux density; Faraday's law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's work law in differential form; Magnetic vector potential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields. *(10 Lectures)*

***PART-B***

**UNIT-III**

**Maxwell's Equations and Poynting Vector:** Equation of continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations with physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Concept of Poynting vector; Poynting Theorem. *(11 Lectures)*

**UNIT-IV**

**Electromagnetic Waves:** Wave equation in free space or non-conducting or lossless medium; wave equation for conducting medium; wave propagation in lossless and conducting medium (phasor form); Propagation characteristics of EM waves in free space, lossless and in conducting medium; Uniform plane waves and solution; relation between electric and magnetic fields of an electromagnetic wave; Linear, circular and elliptical polarization; depth of penetration, Reflection of waves by a perfect conductor: normal incidence and oblique incidence; Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence. *(12 Lectures)*

**Reference Books:**

1. David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4 edition.
2. Edward C Jordan and Keith G Balmain, Electromagnetic waves and radiating systems, Prentice Hall
3. Kraus John D, Electromagnetics, McGraw-Hill Publisher
4. W. Saslow, Electricity, magnetism and light, Academic Press
5. A Textbook of Electricity and Magnetism, Magnetism, S K Sharma, Shalini Sharma, Publisher: S Dinesh & Co.

| | | | |
|---|---|---|---|
| **UC-BSHP-113-19** | **Physics Lab-I** | **L-0, T-0, P-4** | **2 Credits** |

**Pre-requisite (If any):** High-school education

**Course Objectives:** The aim and objective of the lab course is to introduce the students to the formal structure of electromagnetism and phenomenon of wave optics so that they can use these as per their requirement.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Able to verify the theoretical concepts/laws learnt in theory courses. |
| **CO2** | Trained in carrying out precise measurements and handling sensitive equipment. |
| **CO3** | Understand the methods used for estimating and dealing with experimental uncertainties and systematic "errors". |
| **CO4** | Learn to draw conclusions from data and develop skills in experimental design. |
| **CO5** | Document a technical report which communicates scientific information in a clear and concise manner. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 1 | - | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | - | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 3 | 2 | 3 |
| **CO5** | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 3 | 2 | 3 |

**Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.**

**List of experiments:**

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the laser beam characteristics like; wave length, aperture, spot size, etc. using diffraction grating.
3. To study the diffraction using laser beam and thus to determine the grating element.
4. To study wavelength and laser interference using Michelson's Interferometer.
5. To find the refractive index of a material/glass using spectrometer.
6. To find the refractive index of a liquid using spectrometer.
7. To determine the resolving power of a prism.
8. To study the magnetic field of a circular coil carrying current using a Steward and Gees Tangent Galvanometer.
9. Determine the radius of circular coil using the Circular coil.
10. To study B-H curve using CRO.
11. To find out polarizability of a dielectric substance.
12. To find out the horizontal component of earth's magnetic field ($B_h$).

**Text and Reference Books:**

1. A Text -book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
2. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
4. Practical Physics, C L Arora. S. Chand & Company Ltd.
5. http://www.vlab.co.in

| UC-BSHM-XXX-19 | CALCULUS | L-4, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Mathematics

**Course Objectives:** which will act as a strong background if he/she chooses to pursue physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | |
| **CO2** | |
| **CO3** | |
| **CO4** | |
| **CO5** | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

## *PART-A* (Functions of Single Variable)

### UNIT-I

Functions, limit, continuity, differentiability, derivative of elementary functions, higher order derivatives. Applications of derivative: increasing decreasing functions, extreme values of functions. Mean value theorems.

### UNIT-II

Indefinite integral of a real function, Riemann sums, definite integral and its properties, fundamental theorem of calculus, application of definite integral in finding length of an arc and area enclosed between two curves. Finding volumes by slicing. Volumes of solids of Revolution-Disks and Washers. Cylindrical Shells. Lengths of plane curves. Areas of surfaces of revolution.

**PART-B (Functions of Several Variables)**

**UNIT-III**

Functions of several variables, limits, continuity, partial derivatives, homogeneous functions, Euler's theorem, total derivatives, Jacobians, maxima-minima of functions of several variables, Lagrange's method of undetermined multipliers.

**UNIT-IV**

Double integrals, change of order of integration, double integral in polar coordinates, triple integrals, change of variables, simple applications in finding area enclosed by curves and volume of solids.

**TEXT AND REFERECNCE BOOK**

- Robert Wrede and Murray R. Spiegel, Advanced Calculus, 3rd Edition, Schaum's Outline Series (McGraw Hill), 2010.
- Maurice D Weir, Frank R. Giordano and Joel Hass, Thomas' Calculus, 11th Edition, Pearson, 2008.
- James Stewart, Calculus, 5th Edition, Brooks/Cole (Thomson), 2003.

| UC-BSHC-XXX-19 | INORGANIC CHEMISTRY | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Physics and Mathematics

**Course Objectives:** which will act as a strong background if he/she chooses to pursue physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | |
| **CO2** | |
| **CO3** | |
| **CO4** | |
| **CO5** | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**UNIT-I**
**Atomic Structure:**
Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: deBroglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of $\psi$ and $\psi^2$. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number

**UNIT-II**
**Chemical Bonding-I:**
lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation

energy.
Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution
process.

**UNIT-III**
**Chemical Bonding-II:**
Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions; HCl, $BeF_2$, $CO_2$, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding ($\sigma$ and $\pi$ bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

**UNIT-IV**
**Chemistry of s and p Block Elements:**
Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements.Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

**Reference Books :-**
1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4$^{th}$ Ed.*, Pearson, 2010.
6. Shriver & Atkins, *Inorganic Chemistry 5th Ed.*

| UC-BSHC-XXX-19 | CHEMISTRY LAB-I | L-0, T-0, P-4 | 2 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Chemistry

**Course Objectives:** which will act as a strong background if he/she chooses to pursue physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | |
| **CO2** | |
| **CO3** | |
| **CO4** | |
| **CO5** | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**List of Experiments:**

**(A) Titrimetric Analysis**

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

**(B) Acid-Base Titrations**

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

**(C) Oxidation-Reduction Titrimetry**

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

**Reference text:**

1. Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS.

| UC-BSHX-XXX-19 | Communicative English -I | L-2, T-0, P-0 | 2 Credits |
|---|---|---|---|

**Pre-requisite:** Basic proficiency in Communication Skills

**Course Objectives:** The main objective of this course is:

- To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- To help the students become the independent users of English language
- To develop in them vital communication skills, integral to their personal, social and professional interactions
- To teach them the appropriate language of professional communication
- To prepare them for job market

**Course Outcomes:** At the end of the course, the student will

| | |
|---|---|
| **CO1** | acquire basic proficiency in reading &listening, writing and speaking skills |
| **CO2** | be able to understand spoken and written English language, particularly the language of their chosen technical field. |
| **CO3** | be able to converse fluently. |
| **CO4** | be able to produce on their own clear and coherent texts. |
| **CO1** | become proficient in professional communication, such as, interviews, group discussions, office environments, important reading skills as well as writing skills and thereby will have better job prospects. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO2** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |

**Detailed Syllabus:**

**Part –A**

**UNIT I-(Literature)**

**(A)** ***The Poetic Palette*** **(Orient Black Swan, Second Edition, 2016)**

The following poems from this anthology are prescribed:

1. Pippa's Song: Robert Browning
2. Apparently With No Surprise: Emily Dickinson
3. Fool and Flea: Jeet Thayil

**(B)** ***Prose Parables*** **(Orient Black Swan, 2013)**

The following stories from the above volume are prescribed:

a. The Kabuliwallah : Rabindranath Tagore
b. The Eyes Are Not Here: Ruskin Bond
c. Grief: Anton Chekov

**UNIT-II**

**Vocabulary: Word Formation Processes;** Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms

**Grammar:** Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles Determiners; Modals; Prepositions;

**PART-B**

**UNIT-III**

**Reading and Understanding:** Close Reading; Comprehension;

**UNIT-IV**

**Mechanics of Writing & Speaking Skills**

Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self Introductions; Group Discussion

**TEXT AND REFERENCE BOOK**

1. John Eastwood, Oxford Practice Grammar, Oxford University Press, 2014
2. Michael Swan, Practical English Usage, OUP. 1995.
3. F.T. Wood, Remedial English Grammar, Macmillan. 2007.
4. William Zinsser, On Writing Well, Harper Resource Book 2001.
5. Sanjay Kumar and Pushp Lata, Oxford University Press. 2011.
6. Communication Skills, Oxford University Press. 2011.
7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

| **UC-BSHX-XXX-19** | **ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ ( Punjabi Compulsory)-I** | **L-2, T-0, P-0** | **2 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Punjabi

**Course Objectives:** The objective of the course is:
1.To enhance the language ability of students.
2.To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Translate and transfer/broadcast the western scientific knowledge in the local language. |
| **CO2** | Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages. |
| **CO3** | Understand the society through Punjabi language, literature and culture |
| **CO4** | Learning science and in developing science literacy. |
| **CO5** | Improve the internal communication. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**UNIT I : ਕਵਿਤਾ ਭਾਗ:**

ਭਾਈ ਵੀਰ ਸਿੰਘ:

ਸਮਾਂ, ਚਸ਼ਮਾ

ਪ੍ਰੋ. ਪੂਰਨ ਸਿੰਘ :

ਪੰਜਾਬ ਨੂੰ ਕੂਕਾਂ ਮੈਂ, ਹੱਲ ਵਾਹੁਣ ਵਾਲੇ

ਪ੍ਰੋ.ਮੋਹਨ ਸਿੰਘ :

ਮਾਂ, ਕੋਈ ਆਇਆ ਸਾਡੇ ਵਿਹੜੇ, ਪਿਆਰ ਪੰਧ

ਅੰਮ੍ਰਿਤਾ ਪ੍ਰੀਤਮ:

ਆਖਾਂ ਵਾਰਿਸ ਸ਼ਾਹ ਨੂੰ, ਅੰਨਦਾਤਾ *(Lecture 11)*

**UNIT-II ਕਹਾਣੀ ਭਾਗ:**

ਸੰਤ ਸਿੰਘ ਸੇਖੋਂ :

ਪੇਮੀ ਦੇ ਨਿਆਣੇ

ਸੁਜਾਨ ਸਿੰਘ :

ਕੁਲਫੀ

ਕੁਲਵੰਤ ਸਿੰਘ ਵਿਰਕ :

ਤੂੜੀ ਦੀ ਪੰਡ

ਗੁਰਦਿਆਲ ਸਿੰਘ :

ਸਾਂਝ *(Lecture 12)*

***PART-B***

**UNIT-III**

ਭਾਸ਼ਾ ਦਾ ਟਕਸਾਲੀ ਰੂਪ, ਭਾਸ਼ਾ ਤੇ ਉਪ-ਭਾਸ਼ਾ ਵਿਚ ਅੰਤਰ, ਪੰਜਾਬੀ ਦੀਆਂ ਉਪ-ਭਾਸ਼ਾਵਾਂ,ਪੰਜਾਬੀ ਭਾਸ਼ਾ:ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।

ਭਾਸ਼ਾ ਤੇ ਲਿਪੀ, ਗੁਰਮੁਖੀ ਲਿਪੀ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ, ਗੁਰਮੁਖੀ ਲਿਪੀ: ਨਿਕਾਸ ਤੇ ਵਿਕਾਸ।

*(Lecture 11)*

**UNIT-IV**

ਸੰਖੇਪ ਰਚਨਾ (ਪ੍ਰੈਸੀ)
ਪੈਰ੍ਹਾ ਰਚਨਾ
ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਪੈਰ੍ਹੇ ਦਾ ਪੰਜਾਬੀ ਅਨੁਵਾਦ

*(Lecture 11)*

**TEXT AND REFERENCE BOOK:**

1. ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

| UC-BSHX-XXX-19 | ਮੁਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-I | L-2, T-0, P-0 | 2 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Physics and Mathematics

**Course Objectives:** The objective of the course is to:
1. enhance the language ability of students.
2. enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Translate and transfer/broadcast the western scientific knowledge in the local language. |
| **CO2** | Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages. |
| **CO3** | Understand the society through Punjabi language, literature and culture. |
| **CO4** | Learning science and in developing science literacy. |
| **CO5** | Improve the internal communication. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**UNIT I**

ਪੈਂਤੀ ਅੱਖਰੀ ( ਵਰਣਮਾਲਾ), ਅੱਖਰ ਕ੍ਰਮ

ਮਾਤਰਾਵਾਂ : ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ

ਲਗਾਖਰ :ਬਿੰਦੀ, ਟਿੱਪੀ, ਅੱਧਕ

**UNIT-II**

ਪੰਜਾਬੀ ਸ਼ਬਦ ਬਣਤਰ: ਮੁਢਲੀ ਜਾਣ-ਪਛਾਣ

ਮੂਲ ਸ਼ਬਦ , ਅਗੇਤਰ, ਪਿਛੇਤਰ

ਸਮਾਨਾਰਥਕ ਸ਼ਬਦ, ਵਿਰੋਧਾਰਥਕ ਸ਼ਬਦ

ਸ਼ੁੱਧ- ਅਸ਼ੁੱਧ: ਦਿੱਤੇ ਪੈਰ੍ਹੇ ਵਿੱਚੋਂ ਅਸ਼ੁੱਧ ਸ਼ਬਦ ਨੂੰ ਸ਼ੁੱਧ ਕਰਨਾ (11 Lectures)

***PART-B***

**UNIT-III**

ਹਫਤੇ ਦੇ ਸੱਤ ਦਿਨਾਂ ਦੇ ਨਾਂ

ਬਾਰ੍ਹਾਂ ਮਹੀਨਿਆਂ ਦੇ ਨਾਂ

ਰੁੱਤਾਂ ਦੇ ਨਾਂ

ਇਕ ਸੌ ਤੱਕ ਗਿਣਤੀ ਸ਼ਬਦਾਂ ਵਿਚ

**UNIT-IV**

ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ

ਸਧਾਰਣ ਸ਼ਬਦਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ

**TEXT AND REFERENCE BOOK**

1.ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

# SEMESTER -II

| **UC-BSPH-121-19** | **Waves and Vibrations** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level physics and Mathematics

**Course Objectives:** The objective of the course provides an exposure about simple harmonic motions, damped harmonic motions and forced oscillations. Students learns about the different waves, propagation of waves in various mediums and reflection/transmission of waves at the interface of mediums.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the simple and damped harmonic motion of an oscillator. |
| **CO2** | Understand Forced Vibrations and phenomenon of Resonance |
| **CO3** | Apply the Coupled oscillator to the real life problems. |
| **CO4** | Understand the transmission of signals and Electromagnetic Waves |
| **CO5** | Apply the knowledge obtained in this course to day-to-day problems. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | - | 1 | - | 1 | 2 | - | 2 | 3 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | - | 1 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | - | 2 | 1 | 1 | 2 | - | 1 | 3 | 2 | 3 |
| **CO4** | 2 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 1 |
| **CO5** | 2 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 |

**Detailed Syllabus:**

## *PART-A*

### UNIT-I

**Simple and Damped Harmonic Motion:** Simple harmonic motion, energy of a SHO, Compound pendulum, Torsional pendulum, Electrical Oscillations, Lattice Vibrations, Transverse Vibrations of a mass on a string, Anharmonic Oscillations. Damped simple harmonic motion, Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients – Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping. (12 Lectures)

### UNIT-II

**Forced Vibrations and Resonance**: Forced mechanical and electrical oscillator, Transient and Steady State Oscillations, Displacement and velocity variation with driving force frequency, Variation of phase with frequency resonance, Power supplied to forced oscillator by the driving force. Q-factor and band width of a forced oscillator, Electrical and nuclear magnetic resonances. (12 lectures)

## *PART-B*

### UNIT-III

**Coupled Oscillations**: Stiffness coupled oscillators, Normal coordinates and modes of vibrations. Inductance coupling of electrical oscillators, Normal frequencies, Forced vibrations and resonance for coupled oscillators, Masses on string-coupled oscillators.

**Waves in Physical Media**: Types of waves, wave equation (transverse) and its solution characteristics impedance of a string, Impedance matching, Reflection and Transmission of waves at boundary, Energy of vibrating string, wave and group velocity. (12 Lectures)

### UNIT-IV

**Transmission of signals and Electromagnetic Waves:** Transmission of a non-monochromatic wave, Frequency range and Signal duration, Bandwidth theorem, Group and phase velocities, Electromagnetic theory of dispersion, Doppler effect, Electromagnetic (EM) waves: Maxwell Equations, Wave equation, EM waves in a medium of finite $\varepsilon$, $\mu$ and $\sigma$. Energy flow due to a plane EM wave, EM waves in a conducting medium, Skin depth. (12 Lectures)

**Text and Reference Books:**

1. Text Book of Vibrations and Waves: S.P. Puri (Macmillan India), 2004.
2. The Physics of Vibrations and Waves: H.J. Pain (Wiley and ELBS), 2013.
3. N.K. Bajaj, The Physics of Waves and Oscillations, Tata McGraw Hill, 1998.

| **UC-BSHP-122-19** | **Mechanics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Physics and Mathematics

**Course Objectives:** The aim and objective of the course on Mechanics is to introduce the students to the formal structure of vector mechanics, harmonic oscillators, and mechanics of solids so that they can use these in Engineering as per their requirement. This will act as a strong background if he/she chooses to pursue higher studies in physics.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the fundamentals of vector mechanics for a classical system. |
| **CO2** | Identify various types of forces in nature, frames of references, and conservation laws. |
| **CO3** | Know the inertial and non-inertial system. |
| **CO4** | Understand the Gravitation force as a Central Force Motion |
| **CO5** | Apply the knowledge obtained in this course to day-to-day problems. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | - | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | - | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO5** | 2 | 2 | - | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |

**Detailed Syllabus:**

**UNIT I:**

**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket. (12 Lectures)

**UNIT II:**

**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Force as gradient of potential energy. Work done by non-conservative forces. Law of conservation of Energy.

**Collisions:** Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frame of references. (12 Lectures)

**UNIT-III**

**Non-Inertial Systems:** Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

(12 Lectures)

**UNIT-IV**

**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and fields due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). (12 Lectures)

**Text and Reference Books:**

1. Mechanics, Berkeley Physics, Vol.1,C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
2. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons
5. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
6. Physics for scientists and Engineers with Modern Phys., J.W.Jewett, R.A.Serway, 2010, Cengage Learning
7. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

| UC-BSHP-123-19 | Physics Lab-II | L-0, T-0, P-4 | 2 Credits |
|---|---|---|---|

**Pre-requisites (if any):** High-school education with Physics lab as one of the subject.

**Course Objectives:** The aim and objective of the Physics Lab course is to introduce the students of B. Sc. (Hons.) Physics to the formal structure of wave and vibrations and mechanics so that they can use these as per their requirement.

**Course Outcomes:** At the end of the course, the student will be

| | |
|---|---|
| **CO1** | Able to understand the theoretical concepts learned in the theory course. |
| **CO2** | Trained in carrying out precise measurements and handling equipment. |
| **CO3** | Learn to draw conclusions from data and develop skills in experimental design. |
| **CO4** | Able to understand the principles of error analysis and develop skills in experimental design. |
| **CO5** | Able to document a technical report which communicates scientific information in a clear and concise manner. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 1 | - | 2 | 2 | 1 | 1 | 1 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | - | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 3 | 2 | 3 |
| **CO5** | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 3 | 2 | 3 |

**Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.**

**List of experiments:**

1. Measurements of length (or diameter) using vernier caliper and screw gauge.
2. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
3. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
4. To verify the law of vibrating string Using Melde's experiment.
5. To compare mass per unit length of two strings by Melde's experiment.
6. To find out the frequency of AC mains using electric-vibrator/sonometer.
7. To determine the horizontal and vertical distance between two points using a Sextant.
8. To determine the height of an inaccessible object using a Sextant.
9. To determine the angular diameter of the sun using the sextant.
10. To determine the angular acceleration $\alpha$, torque $\tau$, and Moment of Inertia of flywheel.
11. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of **g** and (c) Modulus of rigidity.
12. To determine the time period of a simple pendulum for different length and acceleration due to gravity.
13. To study the variation of time period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
14. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.

**Reference book and suggested readings:**

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. Practical Physics, C L Arora. S. Chand & Company Ltd.
7. http://www.vlab.co.in

| UC-BSHM-XXX-19 | MATHEMATICS | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|
| **Pre-requisite:** Understanding of senior secondary level Mathematics | | | |
| **Course Objectives:** which will act as a strong background if he/she chooses to pursue physics as a career. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | | | |
| **CO2** | | | |
| **CO3** | | | |
| **CO4** | | | |
| **CO5** | | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**UNIT I**

**UNIT-II**

***PART-B***

**UNIT-III**

**UNIT-IV**

**TEXT AND REFERENCE BOOK**

| UC-BSHC-XXX-19 | ORGANIC CHEMISTRY | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Physics and Mathematics

**Course Objectives:** which will act as a strong background if he/she chooses to pursue physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | |
| **CO2** | |
| **CO3** | |
| **CO4** | |
| **CO5** | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**Unit-I**

**Basics of Organic Chemistry**

*Organic Compounds:* Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. *Electronic Displacements:* Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleo phlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

**Unit-II**

**Stereochemistry:**

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

*Optical Isomerism:* Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemicmixture and resolution. Relative and absolute configuration: D/L and R/S designations.

A. Carbon-Carbon sigma bonds formation:-

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

***PART-B***

**Unit-III**

**Carbon-Carbon pi bonds:**

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

*Reactions of alkenes:* Electrophilic additions their mechanisms (Markownikoff/ AntiMarkownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. *Reactions of alkynes:* Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

**Unit-IV**

**Cycloalkanes and Conformational Analysis**

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

**Aromatic Hydrocarbons**

*Aromaticity:* Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

**Text and Reference Books:**

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

| UC-BSHC-XXX-19 | CHEMISTRY LAB-II | L-0, T-0, P-2 | 2 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Chemistry

**Course Objectives:** which will act as a strong background if he/she chooses to pursue physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | |
| **CO2** | |
| **CO3** | |
| **CO4** | |
| **CO5** | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**List of Experiments:**

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents: a) Water b) Alcohol, and c) Alcohol-Water.
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100°C by distillation and capillary method)
6. Chromatography a) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b) Separation of a mixture of two sugars by ascending paper chromatography, c) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

**Reference Books**

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012).

| UC-BSHX-XXX-19 | Communicative English-II | L-2, T-0, P-0 | 2 Credits |
|---|---|---|---|

**Pre-requisite:** Basic proficiency in communicative English

**Course Objectives:** This course is designed to

- help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- help the students become the independent users of English language
- develop in them vital communication skills, integral to their personal, social and professional interactions
- teach them the appropriate language of professional communication
- prepare them for job market

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Students will acquire basic proficiency in reading &listening, writing and speaking skills. |
| **CO2** | Students will be able to understand spoken and written English language, particularly the language of their chosen technical field. |
| **CO3** | They will be able to converse fluently. |
| **CO4** | They will be able to produce on their own clear and coherent texts. |
| **CO5** | Students will become proficient in professional communication such as interviews, group discussions, office environments, important reading skills as well as writing skills and thereby will have better job prospects. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO2** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO3** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO4** | 1 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 2 | - | - | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |

**Detailed Syllabus:**

**Part –A**

**UNIT I-(Literature)**

**(A) *The Poetic Palette* (Orient Black Swan, Second Edition, 2016)**

The following poems from this anthology are prescribed:

1. The Soul's Prayer: Sarojini Naidu
2. I Sit and Look Out: Walt Whitman
3. Women's Rights: Annie Louise Walker

**(B) *Prose Parables* (Orient Black Swan, 2013)**

The following stories from the above volume are prescribed:

1. The Doctor's Word: R.K. Narayan
2. The Doll's House: Katherine Mansfield
3. Dusk: H.H. Munroe (Saki)

**UNIT-II**

**Vocabulary:** Standard abbreviations; One word substitution; Word Pairs (Homophones/ Homonyms)

**Grammar:** Sentence Structures; Use of phrases and clauses in sentences; Transformation of Sentences; Importance of proper punctuation

**PART-B**

**UNIT-III**

**Reading and Understanding:** Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)

**UNIT-IV**

**Mechanics of Writing & Speaking Skills:** Report writing; Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations

**TEXT AND REFERENCE BOOK**

1. John Eastwood, Oxford Practice Grammar, Oxford University Press, 2014
2. Michael Swan, Practical English Usage, OUP. 1995.
3. F.T. Wood, Remedial English Grammar, Macmillan. 2007.
4. William Zinsser, On Writing Well, Harper Resource Book 2001.
5. Sanjay Kumar and Pushp Lata, Oxford University Press. 2011.
6. Communication Skills, Oxford University Press. 2011.
7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

| UC-BSHP-XXX-19 | ਪੰਜਾਬੀ ਲਾਜ਼ਮੀ ( Punjabi Compulsory)-II | L-2, T-0, P-0 | 2 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Punjabi

**Course Objectives:** The objective of the course is to enhance the ability of via Learning science and developing science literacy through local language teaching with science subjects.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Translate and transfer/broadcast the western scientific knowledge in the local language. |
| **CO2** | Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages. |
| **CO3** | Understand the society through Punjabi language, literature and culture |
| **CO4** | Learning science and in developing science literacy. |
| **CO5** | Improve the internal communication. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**UNIT I :**

ਡਾ.ਹਰਿਭਜਨ ਸਿੰਘ:

ਅਪ੍ਰਮਾਣਿਕ, ਤੇਰੇ ਹਜ਼ੂਰ ਮੇਰੀ ਹਾਜ਼ਰੀ ਦੀ ਦਾਸਤਾਨ

ਸ਼ਿਵ ਕੁਮਾਰ ਬਟਾਲਵੀ:

ਕੰਡਿਆਲੀ ਥੋਹ੍ਰ, ਧਰਮੀ ਬਾਬਲ ਪਾਪ ਕਮਾਇਆ, ਰੁੱਖ

ਪਾਸ਼:

ਇਨਕਾਰ,ਸਭ ਤੋਂ ਖਤਰਨਾਕ,ਦਹਿਕਦੇ ਅੰਗਿਆਰਾਂ ‘ਤੇ

ਸੁਰਜੀਤ ਪਾਤਰ:

ਹੁਣ ਘਰਾਂ ਨੂੰ ਪਰਤਣਾ, ਕੁਝ ਕਿਹਾ ਤਾਂ..., ਪੁਲ *(Lecture 12)*

**UNIT-II**

**ਕਹਾਣੀ ਭਾਗ:**

ਸੰਤੋਖ ਸਿੰਘ ਧੀਰ:

ਕੋਈ ਇਕ ਸਵਾਰ

ਪ੍ਰੇਮ ਪ੍ਰਕਾਸ਼:

ਲੱਛਮੀ

ਮੋਹਨ ਭੰਡਾਰੀ :

ਘੋਟਣਾ

ਵਰਿਆਮ ਸਿੰਘ ਸੰਧੂ :

ਆਪਣਾ ਆਪਣਾ ਹਿੱਸਾ *(Lecture 11)*

***PART-B***

**UNIT-III**

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਦੀਆਂ ਵਿਸ਼ੇਸ਼ਤਾਵਾਂ

ਪੰਜਾਬੀ ਭਾਸ਼ਾ ਉਪਰ ਪਏ ਪ੍ਰਭਾਵ *(Lecture 12)*

**UNIT-IV**

ਰਿਪੋਰਟਿੰਗ, ਸਮਾਚਾਰ ਲਿਖਣ ਦੀ ਵਿਧੀ ਤੇ ਤੱਤ

ਪੰਜਾਬੀ ਪੈਰ੍ਹੇ ਦਾ ਸਰਲ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ

ਦਫਤਰੀ ਚਿੱਠੀ ਪੱਤਰ

**TEXT AND REFERENCE BOOK:**

1. ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

| **UC-BSHX-XXX-19** | **ਮੁਢਲੀ ਪੰਜਾਬੀ (Mudhli Punjabi)-II** | **L-2, T-0, P-0** | **2 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of senior secondary level Physics and Mathematics

**Course Objectives:** The objective of the course is:
1.To enhance the language ability of students.
2.To enhance the ability of Learning science and developing science literacy through local language teaching with science subjects.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Translate and transfer/broadcast the western scientific knowledge in the local language. |
| **CO2** | Translate and transfer the indigenous/traditional scientific knowledge available in local knowledge into English and other global languages. |
| **CO3** | Understand the society through Punjabi language, literature and culture. |
| **CO4** | Learning science and in developing science literacy. |
| **CO5** | Improve the internal communication. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | |
| **CO5** | | | | | | | | | | | | |

**Detailed Syllabus:**

***PART-A***

**UNIT I**
ਸ਼ਬਦ ਸ਼੍ਰੇਣੀਆਂ : ਪਛਾਣ ਤੇ ਵਰਤੋਂ-

ਨਾਂਵ

ਪੜਨਾਂਵ

ਵਿਸ਼ੇਸ਼ਣ

ਕਿਰਿਆ

ਕਿਰਿਆ ਵਿਸ਼ੇਸ਼ਣ (12 Lectures)

**UNIT-II**
ਰੋਜ਼ਾਨਾ ਵਰਤੋਂ ਦੀ ਪੰਜਾਬੀ ਸ਼ਬਦਾਵਲੀ:

ਬਾਜ਼ਾਰ, ਵਪਾਰ, ਰਿਸ਼ਤੇ-ਨਾਤੇ ਤੇ ਕਿੱਤਿਆਂ ਸਬੰਧੀ। (12 Lectures)

***PART-B***

**UNIT-III**
ਪੰਜਾਬੀ ਵਾਕ ਬਣਤਰ :

ਸਧਾਰਣ ਵਾਕ

ਸੰਯੁਕਤ ਵਾਕ

ਮਿਸ਼ਰਤ ਵਾਕ

(12 Lectures)

**UNIT-IV**

ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਅੰਗਰੇਜ਼ੀ ਤੋਂ ਪੰਜਾਬੀ ਅਨੁਵਾਦ

ਸਧਾਰਣ ਵਾਕਾਂ ਦਾ ਪੰਜਾਬੀ ਤੋਂ ਅੰਗਰੇਜ਼ੀ ਅਨੁਵਾਦ (11 Lectures)

**TEXT AND REFERENCE BOOK:**

1. ਸੰਪ.ਡਾ.ਮਹਿਲ ਸਿੰਘ, ਸਾਹਿਤ ਦੇ ਰੰਗ, ਰਵੀ ਸਾਹਿਤ ਪ੍ਰਕਾਸ਼ਨ, ਅੰਮ੍ਰਿਤਸਰ, 2016.

**Annexure-III**

# M.Sc. Physics

## Course Structure and Syllabus

## (Based on Choice Based Credit System)

## 2019 onwards

# M.Sc. (Physics) Program

**Duration: 2 Years (Semester System)**

This M.Sc. (Physics) Program includes various core, electives, and other interdisciplinary courses. The diverse lab experiments allow students to understand the fundamental aspects of the subject. A choice of advanced elective courses offers a glimpse in the frontier areas of research and allow students to work on research project as an integral part of their M.Sc. program. The program also provides adequate exposure to the students for pursuing higher education in the field of technology, research and development in Physics and related areas (M.Phil./Ph.D.) and other job opportunities in academia and industry.

**Eligibility:**

Pass B.Sc. with 50% marks having Physics as one of the subject. A relaxation of 5% is given in case of candidates belonging to SC/ST category.

**PROGRAM EDUCATIONAL OBJECTIVES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PEO1 | Apply principles of basic scientific concepts in understanding, analysis, and prediction of physical systems. |
| PEO2 | Develop human resource with specialization in theoretical and experimental techniques required for career in academia, research and industry. |
| PEO3 | Engage in lifelong learning and adapt to changing professional and societal needs. |

**PROGRAM OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PO1 | Apply the scientific knowledge to solve the complex physics problems. |
| PO2 | Identify, formulate, and analyze advanced scientific problems reaching substantiated conclusions using first principles of mathematics, physical, and natural sciences. |
| PO3 | Design solutions for advanced scientific problems and design system components or processes that meet the specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal consideration. |
| PO4 | Use research-based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| PO5 | Create, select, and apply appropriate techniques, resources, and modern scientific tools to complex physics problems with an understanding of the limitations. |
| PO6 | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional scientific practice. |
| PO7 | Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | Apply ethical principles and commit to the norms of scientific practice. |
| PO9 | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | Communicate effectively on scientific activities with the Scientific/Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | Demonstrate knowledge and understanding of the scientific principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO12 | Recognize the need for,and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change. |

**PROGRAM SPECIFIC OUTCOMES:** At the end of the program, the student will be able to:

| | |
|---|---|
| PSO1 | Understand the basic and advance concepts of different branches of physics. |
| PSO2 | Perform and design experiments in the areas of electronics, atomic, nuclear, condensed matter, and computational physics. |
| PSO3 | Apply the concepts of physics in specialized areas of condensed, nuclear, renewable energies, particle physics, etc., in industry, academia, research and day today life. |

**SEMESTER FIRST**

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | Internal | External | | |
| UC-MSPH-411-19 | Mathematical Physics-I | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-412-19 | Classical Mechanics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-413-19 | Quantum Mechanics-I | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-414-19 | Electronics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-415-19 | Computational Physics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-416-19 | Electronics Lab | - | - | 6 | 50 | 25 | 75 | 3 |
| UC-MSPH-417-19 | Computational Physics Lab-I | - | - | 6 | 50 | 25 | 75 | 3 |
| **TOTAL** | | 15 | 5 | 12 | 250 | 400 | 650 | 26 |

**SEMESTER SECOND**

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | Internal | External | | |
| UC-MSPH-421-19 | Mathematical Physics-II | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-422-19 | Statistical Mechanics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-423-19 | Quantum Mechanics-II | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-424-19 | Classical Electrodynamics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-425-19 | Atomic and Molecular Physics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-426-19 | Atomic, Nuclear, and Particle Physics Lab | - | - | 6 | 50 | 25 | 75 | 3 |
| UC-MSPH-427-19 | Computational Physics Lab-II | - | - | 6 | 50 | 25 | 75 | 3 |
| | **TOTAL** | 15 | 5 | 12 | 250 | 400 | 650 | 26 |

**L: Lectures T: Tutorial P: Practical**

**SEMESTER THIRD**

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | Internal | External | | |
| UC-MSPH-531-19 | Condensed Matter Physics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-532-19 | Nuclear Physics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-533-19 | Particle Physics | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-534-19<br>UC-MSPH-535-19<br>UC-MSPH-536-19 | Elective Subject-I | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-537-19<br>UC-MSPH-538-19<br>UC-MSPH-539-19 | Elective Subject-II | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-540-19 | Condensed Matter Physics Lab | - | - | 6 | 50 | 25 | 75 | 3 |
| **TOTAL** | | **15** | **5** | **6** | **200** | **375** | **575** | **23** |

**SEMESTER FOURTH**

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | Internal | External | | |
| UC-MSPH-541-19<br>UC-MSPH-542-19<br>UC-MSPH-543-19 | Elective Subject-III | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-544-19<br>UC-MSPH-545-19<br>UC-MSPH-546-19 | Elective Subject-IV | 3 | 1 | - | 30 | 70 | 100 | 4 |
| UC-MSPH-547-19 | Dissertation | 12 | | | 200 | 100 | 300* | 12 |
| **TOTAL** | | **6** | **14** | | **260** | **240** | **500** | **20** |

***Evaluation criteria as per IKGPTU norms.**

**TOTAL NUMBER OF CREDITS = 95**

## LIST OF DEPARTMENTAL/INTERDISCIPLINARY ELECTIVES

### Elective Subject-I

| S. No. | Name of the Subject | Code |
|---|---|---|
| 1 | Fibre optics and non-linear optics | UC-MSPH-534-19 |
| 2 | Radiation Physics | UC-MSPH-535-19 |
| 3 | Nonlinear Dynamics | UC-MSPH-536-19 |

### Elective Subject -II

| S.No. | Name of the Subject | Code |
|---|---|---|
| 1 | Plasma Physics | UC-MSPH-537-19 |
| 2 | Structures, Spectra and Properties of Biomolecules | UC-MSPH-538-19 |
| 3 | Science of Renewable Source of Energy | UC-MSPH-539-19 |

### Elective-III

| S.No. | Name of the Subject | Code |
|---|---|---|
| 1 | Physics of Nanomaterials | UC-MSPH-541-19 |
| 2 | Experimental Techniques in Nuclear and Particle Physics | UC-MSPH-542-19 |
| 3 | Superconductivity and Low Temperature Physics | UC-MSPH-543-19 |

### Elective-IV

| | Name of the Subject | Code |
|---|---|---|
| 1 | Advanced Condensed Matter Physics | UC-MSPH-544-19 |
| 2 | Advanced Particle Physics | UC-MSPH-545-19 |
| 3 | Environment Physics | UC-MSPH-546-19 |

**Examination and Evaluation**

| **Theory** | | | |
|---|---|---|---|
| **S. No.** | **Evaluation criteria** | **Weightage in Marks** | **Remarks** |
| 1 | Mid term/sessional Tests | 20 | Internal evaluation (30 Marks)<br>MSTs, Quizzes, assignments, attendance, etc., constitute internal evaluation. Average of two mid semester test will be considered for evaluation. |
| 2 | Attendance | 5 | |
| 3 | Assignments | 5 | |
| 4 | End semester examination | 70 | External evaluation (70 Marks) |
| 5 | Total | 100 | Marks may be rounded off to nearest integer. |
| **Practical** | | | |
| 1 | Evaluation of practical record/ Viva Voice | 30 | Internal evaluation (50 Marks) |
| 2 | Attendance | 5 | |
| 3 | Seminar/Presentation | 15 | |
| 4 | Final Practical Performance + Viva Voice | 25 | External evaluation (25 Marks) |
| 5 | Total | 75 | Marks may be rounded off to nearest integer. |

## Instructions for End semester Paper-Setter in M. Sc. Physics

### A. Scope

1. The question papers should be prepared strictly in accordance with the prescribed syllabus and pattern of question paper of the University.
2. The question paper should cover the entire syllabus uniformly covering each chapter thoroughly with proper distribution.
3. Each unit of course/syllabus carries weightage according to the number of lectures mentioned in syllabus. (1 Lecture ~ 2 Marks)
4. The language of questions should be simple, direct, and documented clearly and unequivocally so that the candidates may have no difficulty in appreciating the scope and purpose of the questions. The length of the expected answer should be specified as far as possible in the question itself.
5. The distribution of marks to each question/answer should be indicated in the question paper properly.

### B. Type and difficulty level of question papers

1. Questions should be framed in such a way as to test the students intelligent grasp of broad principles and understanding of the applied aspects of the subject. The weightage of the marks as per the difficulty level of the question paper shall be as follows:

| | | |
|---|---|---|
| i) | Easy question | 30% |
| ii) | Average questions | 50% |
| iii) | Difficult questions | 20% |

2. The numerical content of the question paper should be upto 20%.

### C. Format of question paper

1. Paper code and Paper-ID should be mentioned properly.
2. The question paper will consist of three sections: Sections-A, B, and C.
3. Section-A is COMPULSORY consisting of TEN SHORT questions carrying two marks each (total 20 marks) covering the entire syllabus.
4. The Section-B consists of SEVEN questions of five marks each covering the entire syllabus.
5. The Section-C consists of THREE questions of ten marks each covering the entire syllabus.
6. Attempt any **SIX** questions from Section-B and any **TWO** from Section-C.

## Question paper pattern for MST:

| | |
|---|---|
| **Roll No:** | **No of pages:** |

| | |
|---|---|
| **IK Gujral Punjab Technical University- Jalandhar** | |
| **Department of Physical Sciences** | |
| **Academic Session:** | |
| **Mid-Semester Test: I/II/III (Regular/reappear)** | **Date:** |
| **Programme:** M.Sc. Physics | **Semester:** |
| **Course Code:** | **Course:** |
| **Maximum Marks: 20** | **Time: 1 hour 30 minutes** |

❖ Note: Section A is compulsory; Attempt any two questions from Section B and one question from Section C.

| **Section: A** | | **Marks** | **COs** |
|---|---|---|---|
| 1 | | 1 | |
| 2 | | 1 | |
| 3 | | 1 | |
| 4 | | 1 | |
| **Section: B** | | | |
| 5 | | 4 | |
| 6 | | 4 | |
| 7 | | 4 | |
| **Section: C** | | | |
| 8 | | 8 | |
| 9 | | 8 | |

*Details of Course Objectives*

| | |
|---|---|
| *CO1* | |
| *CO2* | |
| *CO3* | |
| *CO4* | |
| *CO5* | |

**Guidelines for the evaluation of Dissertation:**

<table>
<tr><th colspan="7">Internal Assessment</th></tr>
<tr><td rowspan="2">Departmental Presentation</td><td colspan="2">Communication and presentation</td><td colspan="2">Response to queries</td><td>Maximum Marks</td><td>Evaluated by</td></tr>
<tr><td colspan="2">20</td><td colspan="2">30</td><td>50</td><td>Committee Member:<br>1.Head<br>2.Supervisor<br>3.One of Faculty Member</td></tr>
<tr><td rowspan="2">Dissertation</td><td>Plagiarism</td><td>Subject Matter</td><td>Usage of Language</td><td>Publication/Presentation in Conference</td><td rowspan="2">150</td><td rowspan="2"></td></tr>
<tr><td>25</td><td>70</td><td>25</td><td>30</td></tr>
<tr><th colspan="7">External Assessment</th></tr>
<tr><td rowspan="2">External Examiner</td><td colspan="4">Subject Matter</td><td rowspan="2">50</td><td rowspan="2"></td></tr>
<tr><td colspan="4">50</td></tr>
<tr><td rowspan="2">Viva Voce</td><td colspan="2">Communication and Presentation</td><td colspan="2">Response to queries</td><td rowspan="2">50</td><td rowspan="2">Committee Member:<br>1.Head<br>2.External Expert<br>3.Supervisor<br>4. Director (MC) nominee</td></tr>
<tr><td colspan="2">20</td><td colspan="2">30</td></tr>
<tr><td colspan="5">Total</td><td>300</td><td></td></tr>
</table>

**Evaluation Process:**

1. The subject matter evaluation can further be defined on the basis of Title, Review of literature/Motivation, Objectives, Methodology, Results and discussions, and Conclusion.
2. The usage of language and the subject matter shall be evaluated by the supervisor. Out of 300 marks, 95 marks are to be evaluated by the concerned supervisor.
3. Total 15% Plagiarism is admissible for submission of the dissertation. For (0-5)% of plagiarism, candidate should be awarded 25 marks. For >5%-10% candidate should be awarded 15 marks and for the range of > 10% to < 15%, candidate should be awarded 5 marks.
4. For publication candidate should be awarded full 30 marks and for presenting the work related to dissertation, candidate should be awarded 25 marks.

| UC-MSPH-411-19 | MATHEMATICAL PHYSICS-I | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level mathematics

**Course Objectives:** The objective of the course on **Mathematical Physics-I** is to equip the M.Sc. students with the mathematical techniques that he/she needs for understanding theoretical treatment in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in physics as a career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Use complex variables for solving definite integral. |
| **CO2** | Use the Delta and Gamma functions for describing physical systems. |
| **CO3** | Solve partial differential equations using boundary value problems. |
| **CO4** | Describe special functions and recurrence relations to solve the physics problems. |
| **CO5** | Use statistical methods to analyse the experimental data. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 3 | - | 2 | 1 | - | 2 | 1 | 1 | 2 |

**Detailed Syllabus:**

1. **Complex Variables**: Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation. *(Lectures 10)*

2. **Delta and Gamma Functions:** Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function. *(Lectures 7)*

3. **Differential Equations:** Partial differential equations of theoretical physics, boundary value, problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution. *(Lectures 8)*

4. **Special Functions:** Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynomials, Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions. *(Lectures 10)*

5. **Elementary Statistics:** Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution. *(Lectures 5)*

**Text Books:**

1. Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, SanDiego) 7th edition, 2011.

**Reference Books:**

1. Mathematical Physics: *P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004*.
2. Mathematical Physics*: A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi),1986.*
3. Mathematical Methods in the Physical Sciences – *M.L. Boas (Wiley, New York) 3rd edition, 2007.*
4. Special Functions: *E.D. Rainville (MacMillan, New York), 1960.*
5. Mathematical Methods for Physics and Engineering: *K.F. Riley, M.P. Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed., 2006.*

| UC-MSPH-412-19 | CLASSICAL MECHANICS | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level physics

**Course Objectives:** The aim and objective of the course on **Classical Mechanics** is to train the students of M.Sc. students in the Lagrangian and Hamiltonian formalisms so that they can use these in the modern branches of physics such as Quantum Mechanics, Quantum Field Theory, Condensed Matter Physics, Astrophysics, etc.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the necessity of Action, Lagrangian, and Hamiltonian formalism. |
| **CO2** | Use d'Alambert principle and calculus of variations to derive the Lagrange equations of motion. |
| **CO3** | Describe the motion of a mechanical system using Lagrange-Hamilton formalism. |
| **CO4** | Apply essential features of a classical problem (like motion under central force, periodic motions) to set up and solve the appropriate physics problems. |
| **CO5** | Appreciate the theory of rigid body motion which is important in several areas of physics e.g., molecular spectra, acoustics, vibrations of atoms in solids, coupled mechanical oscillators, electrical circuits, etc.. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 1 | 1 | - | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 1 | 1 | - | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 1 | 1 | - | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Lagrangian Formulation:** Mechanics of a system of particles; constraints of motion, generalized coordinates, d'Alembert Principle and Lagrange's velocity-dependent forces and the dissipation function, Applications of Lagrangian formulation.
*(Lectures 7)*
2. **Hamilton's Principles:** Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.
*(Lectures 7)*

3. **Hamilton's Equations:** Legendre Transformation, Hamilton's equations of motion, Cyclic coordinates, Hamilton's equations from variational principle, Principle of least action.
*(Lectures 7)*
4. **Canonical Transformation and Hamilton-Jacobi Theory:** Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton- Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom. *(Lectures 10)*

5. **Rigid Body Motion:** Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. *(Lectures 10)*

**Text Books:**

1. Classical Mechanics*: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi),* 3rd ed 2001.
2. Mechanics by L.D. Landau & E.M. Lifschz (Pergamon), 1976.

**Reference Books:**

3. Classical Mechanics of Particles and Rigid Bodies: *K.C. Gupta (Wiley Eastern, New Delhi), 1988.*
4. Classical Mechanics- J. W. Muller- Kirsten (World Scientific) 2008.
5. Advanced Classical & Quantum Dynamics by W. Dittrich, W. And M Reuter, M. (Springer) 1991.
6. Classical mechanics by T.W.B. Kibble and Frank H. Berkshire (Imperial College Press) 2004.
7. Mathematical Methods of Classical Mechanics by V. I. Arnold, (Springer) 1978.

| | | | |
|---|---|---|---|
| **UC-MSPH-413-19** | **Quantum Mechanics-I** | **L-3, T-1, P-0** | **4 Credits** |

**Pre-requisite:** Basic knowledge of wave mechanical quantum mechanics

**Course Objectives:** The aim and objective of the course on **Quantum Mechanics-I** is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the techniques of vector spaces, angular momentum, perturbation theory, and scattering theory so that they can use these in various branches of physics as per their requirement.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the need for quantum mechanical formalism and its basic principles. |
| **CO2** | Appreciate the importance and implication of vector spaces, Dirac ket bra notations, eigen value problem. |
| **CO3** | Understand the implications of generalized uncertainty principle in QM. |
| **CO4** | Better understanding of the mathematical foundations of spin and angular momentum for a system of particles. |
| **CO5** | Solve Schrodinger equation for various QM systems using approximate methods. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |

**Detailed Syllabus:**

1. **Linear Vector Space and Matrix Mechanics:** Vector spaces, Schwarz inequality, Orthonormal basis, Operators: Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation, Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg, Schroedinger and Interaction representations, Exchange operator and identical particles, Density Matrix and Mixed Ensemble. *(Lectures 15)*

2. **Angular Momentum:** Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigen values and eigenvectors of $L^2$ and Lz. Spin angular momentum, General angular momentum, Eigen values and eigenvectors of $J^2$ and Jz. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients. *(Lectures 10)*

3. **Stationary State Approximate Methods:** Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems. *(Lectures 8)*

4. **Time Dependent Perturbation:** General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light. *(Lectures 7)*

**Text Books:**

1. A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 2nd edition, 2004.
2. Quantum Mechanics: V.K. Thankappan (New Age, New Delhi), 2004.

**Reference Books:**

1. Quantum Mechanics: M.P. Khanna (Har Anand, New Delhi), 2006.
2. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
3. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
4. Quantum Physics: S. Gasiorowicz (Wiley, New York), 3rd ed. 2002.
5. Quantum Physics: Concepts and Applications: Nouredine Zettili (Wiley, New York), 2nd ed. 2009.

| **UC-MSPH-414-19** | **Electronics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|
| **Pre-requisite:** Basic knowledge about electronics | | | |
| **Course Objectives:** The aim and objective of the course on **Electronics** is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the knowledge of semiconductor physics, basic circuit analysis, first-order nonlinear circuits, OPAMP based analog circuits and introduction to digital electronics so that they can use these in various branches of physics as per their requirement. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Understand working of Different Semiconductor devices (Construction, Working Principles and V-I characteristics) and their applications. | | |
| **CO2** | Explain the construction and working of Thyristors and use Thyristors for various applications. | | |
| **CO3** | Design Analog and Digital Instruments and their applications. | | |
| **CO4** | Apply Boolean algebra and Karnaugh maps. | | |
| **CO5** | Design the Sequential and Integrated circuits. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Semiconductor Devices and applications:** Direct and indirect semiconductors, Drift and diffusion of carriers, Photoconductors, Semiconductor junctions, Metal-semiconductor junctions - Ohmic and rectifying contacts, Zener diode, Schottky diode, Switching diodes, Tunnel diode, Light emitting diodes, Photodiodes, Solar cell, Liquid crystal displays. *(Lectures 7)*
2. **UJTs and Thyristors:** Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics-Gate Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices- Thyristors in Series and in Parallel; Applications of Thyristors- as a Pulse Generator, Bistable Multivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT. *(Lectures 10)*
3. **Analog and Digital Instruments:** OPAMP and its applications, Time Base; 555 Timer, Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System. *(Lectures 8)*
4. **Digital and Sequential circuits:** Boolean algebra, de Morgans theorem, Karnaugh maps, Flip-Flops – RS, JK, D, COcked, preset and clear operation, race around conditions in JK Flip-flops, master-slave JK flip-flops, Switch contact bounce circuit. Shift registers, Asynchronous and Synchronous counters, Counter design and applications. *(Lectures 8)*
5. **Integrated Circuits as Digital System Building Blocks:** Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM: Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM Elements Bipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter. *(Lectures 8)*

**Text Books:**

1. Text Book of Electronics: *S. Chattopadhyay,* New Central Book Agency P.Ltd., Kolkata, 2006.
2. Digital Principles and Applications: *A.P. Malvino and D.P. Leach,* Tata McGraw-Hill, Publishing Co., New Delhi.

**Reference Books:**

1. Electronics Principles and Applications: *A.B. Bhattacharya*, New Central Book Agency P.Ltd., Kolkata, 2007.
2. Integrated Electronics Analog and Digital Circuits and Systems: *J. Millman, C.C Halkins and C. Parikh*, 2$^{nd}$ Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

| **UC-MSPH-415-19** | **Computational Physics** | **L-3, T-1, P-0** | **4 Credits** |
| --- | --- | --- | --- |

**Pre-requisite:** Understanding of graduate level physics

**Course Objectives:** The aim and objective of the course on **Computational Physics** is to familiarize the students of M.Sc. students with the numerical methods used in computation and programming using any high level language such as Fortran, C++, etc., so that they can use these in solving simple physics problems.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
| --- | --- |
| **CO1** | Apply basics knowledge of computational physics in solving the physics problems. |
| **CO2** | Programme with the C++ or any other high level language. |
| **CO3** | Use various numerical methods in solving physics problems. |
| **CO4** | Analyze the outcome of the algorithm/program graphically. |
| **CO5** | Simulate the physical systems using simulations. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Introduction to Computational Physics:** Need and advantages of high level language in physics, programming in a suitable high level language, input/output, interactive input, loading and saving data, loops branches and control flow, Matrices and Vectors, Matrix and array operations, need for Graphic tools. *(Lectures 11)*

2. **Programming with C++:** Introduction to the Concept of Object Oriented Programming; Advantages of C++ over conventional programming languages; Introduction to Classes, Objects; C++ programming syntax for Input/Output, Operators, Loops, Decisions, simple and inline functions, arrays, strings, pointers; some basic ideas about memory management in C+. *(Lectures 15)*

3. **Numerical methods:** Computer algorithms, interpolations-cubic spline fitting, Numerical differentiation – Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, Random number generators, Numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, eigenvalue problems, Monte Carlo simulations. *(Lectures 15)*

**Text Books:**

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6$^{th}$ ed., 1979.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2$^{nd}$ edition, 2011.

**Reference Books:**

1. Computer Applications in Physics: S. Chandra (Narosa) 2$^{nd}$ edition, 2005.
2. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
3. Object Oriented Programming with C++: Balagurusamy, (Tata McGraw Hill) 4th edition 2008.

| UC-MSPH-416-19 | Electronics Lab | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|
| **Pre-requisite:** Understanding of graduate level physics electronics experiments | | | |
| **Course Objectives:** The aim and objective of the laboratory on **Electronics Lab** is to expose the students of M.Sc. class to experimental techniques in electronics so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment. | | | |
| **Course Outcomes:** At the end of the course, the student will | | | |
| **CO1** | Acquire hands on experience of handling and building electronics circuits. | | |
| **CO2** | Be familiar with the various components such as resistors, capacitor, inductor, IC chips and how to use these components in circuits. | | |
| **CO3** | Be able to understand the construction, working principles and V-I characteristics of various devices such as PN junction diodes, UJT, TRIAC, etc. | | |
| **CO4** | Capable of using components of digital electronics for various applications. | | |
| **CO5** | Able to design and perform scientific experiments as well as accurately record and analyze the results of experiments. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

**Note: Students are expected to perform atleast 10 experiments out of following list.**

1. Study the forward and reverse characteristics of a Semiconctor/Zener diode.
2. Construction of adder, subtracter, differentiator and integrator circuits using the given OP-Amp.
3. Study the static and drain characteristics of a JFET.
4. Construction of an Astable multivibrator circuit using transistor.
5. Construction of a single FET amplifier with common source configuration.
6. To study the operation of Analog to Digital convertor.
7. To study the operation of Digital to Analog convertor.
8. Construction of a low-pass filter circuit and study its output performance.
9. Construction of a high-pass filter circuit and study its output performance.
10. To verify the Dmorgan's law using Logic Gates circuit.
11. To study the Characteristics of Tunnel Diode.
12. To study Amplitude Modulation.
13. To study Frequency Modulation.
14. To study the Characteristics of SCR.
15. To study the Characteristics of MOSFET.
16. To study the Characteristics of UJT.
17. To study the Characteristics of TRIAC.
18. To verify the different Logic and Arithmetic operations on ALU system.
19. To study the operation of Encoders and Decoders.
20. To study the operation of Left and right shift registers.
21. To study the operation of Counters, Ring counters.
22. To determine the thermal coefficient of a thermistor.
23. To study the operation of an Integrated Circuit Timer.

**Text Books:**

1. Text Book of Electronics: *S. Chattopadhyay*, New Central Book Agency P.Ltd., Kolkata, 2006.
2. Digital Principles and Applications: *A.P. Malvino and D.P. Leach,* Tata McGraw-Hill, Publishing Co., New Delhi.

**Reference Books:**

1. Electronics Principles and Applications: *A.B. Bhattacharya*, New Central Book Agency P.Ltd., Kolkata, 2007.
2. Integrated Electronics Analog and Digital Circuits and Systems: *J. Millman, C.C Halkins and C. Parikh*, 2$^{nd}$ Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

| **UC-MSPH-417-19** | **Computational Physics Lab-I** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level numerical methods

**Course Objectives:** The aim and objective of the course on **Computational Physics Lab-I** is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using C++ language so that they can use these in solving simple problems pertaining to physics.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Apply basics knowledge of computational Physics in solving various physical problems. |
| **CO2** | Programme with the C++ or any other high level language. |
| **CO3** | Use various numerical methods in describing/solving physics problems. |
| **CO4** | Solve problem, critical thinking and analytical reasoning as applied to scientific problems. |
| **CO5** | Analyse and reproduce the experimental data. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO5** | 1 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 |

**Detailed Syllabus:**

**Note: Students are expected to perform atleast 10 experiments out of following list using C++ and Gnuplot.**

1. To find the standard deviation, mean, variance, moments etc. of at least 15 entries.
2. To choose a set of 10 values and find the least squared fitted curve.
3. Find y for a given x by fitting a set of values with the help of cubic spline fitting technique.
4. To find the Roots of an Algebraic Equation by Bisection method and secant method
5. To find the Roots of an Algebraic Equation by Newton-Raphson Method.
6. To find the Roots of Linear Equations by Gauss Elimination Method.
7. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
8. Find first order derivative at given x for a set of values with the help of Lagrange interpolation.
9. To perform numerical integration of a function by Trapezoidal Rule.
10. To perform numerical integration of a function by Simpson's Rule.
11. To perform numerical integration of a function by Weddle's rule.
12. To solve a Differential Equation by Euler's method and Modified Euler's Method.
13. To solve a Differential Equation by Runge Kutta method.
14. To find the determinant of a matrix and its eigenvalues and eigenvectors.
15. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.

**Text Books:**

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition, 2011.

**Reference Books:**

1. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition, 2005.
2. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
3. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

| **UC-MSPH-421-19** | **Mathematical Physics-II** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|
| **Pre-requisite**: Understanding of graduate level mathematics | | | |
| **Course Objectives:** The aim and objective of the course on **Mathematical Physics-II** is to equip the M.Sc. Students with the mathematical techniques that he/she needs for understanding theoretical treatment in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in physics as a career. | | | |
| **Course Outcomes:** At the end of the course, the student will able to | | | |
| **CO1** | Understand the basics and aplications of group theory in all the branches of Physics. | | |
| **CO2** | Use Fourier series and transformations as an aid for analyzing physical problems. | | |
| **CO3** | Apply integral transform to solve mathematical problems of Physics interest. | | |
| **CO4** | Formulate and express a physical law in terms of tensors and simplify it by use of coordinate transforms. | | |
| **CO5** | Develop mathematical skills to solve quantitative problems in physics. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | - | 1 | 1 | - | 2 | 1 | 1 | 2 |

**Detailed Syllabus:**

1. **Group Theory:** What is a group? Multiplication table, conjugate elements and classes, subgroups, Isomorphism and Homomorphism, Definition of representation and its properties, Reducible and irreducible representations, Schur's lemmas (only statements), characters of a representation. Example of C4v, Topological groups and Lie groups, three dimensional rotation group, special unitary groups SU(1) and SU(2). *(Lectures 10)*

2. **Tensors:** Introduction, definitions, contraction, direct product. Quotient rule, Levi-Civita symbol, Noncartesian tensors, metric tensor, Covariant differentiation. *(Lectures 7)*

3. **Fourier Series and Integral Transforms:** Fourier series, Dirichlet conditions, General properties, Advantages and applications, Gibbs phenomenon, Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation. *(Lectures 15)*

4. **Integral Equations:** Definitions and classifications, integral transforms and generating functions. Neumann series, Separable Kernels, Hilbert-Schmidt theory, Green's functions in one dimension. *(Lectures 10)*

**Text Books:**

1. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) 2011.
2. Mathematical Methods for Physicists: G. Arfken and H.J. Weber, (Academic Press, San Diego) 7th edition, 2011.

**Reference Books:**

1. Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) 2005.
2. Numerical Mathematical Analysis: J.B. Scarborough (Oxford Book Co., Kolkata) 4th edition.
3. A First Course in Computational Physics: P.L. Devries (Wiley, New York) 1994.
4. Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
5. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) 2006.

| UC-MSPH-422-19 | Statistical Mechanics | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level statistical mechanics

**Course Objectives:** The aim and objective of the course on **Statistical Mechanics** is to equip the M.Sc. student with the techniques of statistical ensemble theory so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Find the connection between Statistical Mechanics and thermodynamics |
| **CO2** | Use ensemble theory to explain the behavior of Physical systems |
| **CO3** | Explain the statistical behavior of Bose-Einstein and Fermi-Dirac systems and their applications. |
| **CO4** | Work with models of phase transitions and thermo-dynamical fluctuations. |
| **CO5** | Describe physical problems using quantum statistics. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | 1 | - | - | - | - | - | 1 | 1 | - | - | - |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 |
| **CO5** | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 |

**Detailed Syllabus:**

1. **The Statistical Basis of Thermodynamics:** The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. *(Lectures 7)*

2. **Ensemble Theory:** Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations. *(Lectures 10)*

3. **Quantum Statistics of Ideal Systems:** Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures, Pauli paramagnetism. *(Lectures 10)*

4. **Elements of Phase Transitions:** Introduction, a dynamical model of phase transitions, Ising model in zeroth approximation. *(Lectures 8)*

5. **Fluctuations:** Thermodynamic fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation. *(Lectures 5)*

**Text Books:**

1. Statistical Mechanics: R.K. Pathria and P.D. Beale (Butterworth-Heinemann, Oxford), 3rd edition, 2011.

**Reference Books:**

1. Statistical Mechanics*: K. Huang (Wiley Eastern, New Delhi), 1987*.
2. Statistical Mechanics: *B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) 2nd edition, 2011*.
3. Elementary Statistical Physics: *C. Kittel (Wiley, New York), 2004.*
4. Statistical Mechanics: *S.K. Sinha (Tata McGraw Hill, New Delhi), 1990.*

| **UC-MSPH-423-19** | **Quantum Mechanics–II** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Preliminary course of Quantum Mechanics

**Course Objectives:** The aim and objective of the course on **Quantum Mechanics-II** is to introduce the M.Sc. students to the formal structure of the subject and to equip him/her with the techniques of Relativistic quantum mechanics and Quantum field theory so that he/she can use these in various branches of physics as per his/her requirement.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Define the relativistic QM as the covariant formulation of quantum mechanics and need for quantum field theory |
| **CO2** | Give the significance of Klein Gordon and Dirac equation and explain the existence of antiparticles. |
| **CO3** | Apply the symmetries principles and Noether's theorem in calculating the conserved currents and charges. |
| **CO4** | Demonstrate the second quantization for scalar, Dirac, and electromagnetic fields. |
| **CO5** | Explain the origin of Feynman diagrams and apply the Feynman rules to derive the amplitudes for elementary processes. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 |
| **CO2** | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | 2 | 1 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 2 |

**Detailed Syllabus:**

1. **Relativistic Quantum Mechanics-I:** Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle, the non-relativistic limit of Dirac equation.
   *(Lectures 10)*
2. **Relativistic Quantum Mechanics-II:** Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lamb shift.
   *(Lectures 10)*
3. **Quantum Field Theory:** Resume of Lagrangian and Hamiltonian formalism of a classical field, Noether theorem, Quantization of real scalar field, complex scalar field, Dirac field and electromagnetic field, Covariant perturbation theory, Wick's theorem, Scattering matrix. *(Lectures 10)*

4. **Feynman diagrams**: Feynman rules, Feynman diagrams and their applications, Yukawa field theory, calculations of scattering cross-sections, decay rates with examples, Quantum Electrodynamics, calculations of matrix elements - for first order and second order.
   *(Lectures 10)*

**Text Books:**

1. Relativistic quantum Mechanics, J D Bjorken and S D Drell, (Tata McGraw Hill, New Delhi) 2012.
2. A first book of Quantum Field Theory, A. Lahiri & P. Pal, (Narosa Publishers, New Delhi), 1st ed. 2005.
3. Introduction to Quantum Field Theory, M. Peskin & D.V. Schroeder. (Levant Books) 2015.

**Reference Books:**

1. Quantum Field Theory in a Nutshell: A Zee (University Press), 2012.
2. *Lecture on Quantum Field Theory, A. Das (World Scientific), 2008.*
3. Text Book of Quantum Mechanics-*P.M. Mathews & K. Venkatesan (Tata McGraw Hill, New Delhi), 2004.*
4. Quantum Field Theory: H. Mandl and G. Shaw *(Wiley, New York*), 2010.
5. Advance Quantum Mechanics: J.J. Sakurai *(Addison- Wesley, Reading*), 2004.

| UC-MSPH-424-19 | Classical Electrodynamics | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level electricity and magnetism

**Course Objectives:** The **Classical Electrodynamics** course covers Electrostatics and Magnetostatics including Maxwell equations, and their applications to propagation of electromagnetic waves in dielectrics; EM waves in bounded media, waveguides, Radiation from time varying sources.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the concept of quadrupole, multipole expansion and dielectric polarization. |
| **CO2** | Explain the magnetic scalar, vector potential and boundary conditions on magnetic fields. |
| **CO3** | Provide solution to various boundary value problems. |
| **CO4** | Use Maxwell equations in different forms and different media and describe the propagation of electromagnetic waves through different media. |
| **CO5** | Develop analytical skills to solve problems related to propagation of EM waves through wave guides. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 3 |
| **CO2** | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 3 |
| **CO4** | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

**Detailed Syllabus:**

1. **Electrostatics:** Electrostatic potential and potential of a charge distribution, dipole moment, Electric Quadrupole and multipoles, Multipole expansion of the scalar potential, Dielectric polarization and its types, Polarization vector, Relation between electric displacement, electric field and Polarisation, Electrostatic energy and energy density in free space and dielectric, Boundary conditions at the interface of two dielectrics. *(Lectures 10)*
2. **Magnetostatics:** Current density, magnetic induction, Force on a current element: Ampere's Force law, Divergence of magnetic induction, Magnetic scalar and vector potential, Boundary conditions on magnetic fields. *(Lectures 6)*
3. **Boundary value problems:** Uniqueness theorem, Green's theorem, Green's reciprocation theorem, Solution of electrostatic boundary value problem with Green function, Method of images with examples; Point charge near an infinite grounded conducting plane; Dielectric slab of infinite face in front of a point charge, Laplace and Poisson's equations in different coordinates, Solution of Laplace equation. *(Lectures 8)*
4. **Maxwell equations and Electromagnetic Waves:** Maxwell equations, Concept of displacement current, Maxwell's equations for free space, static fields and in Phasor notation, Wave equations in free space, non-conducting and conduction medium (Phasor form), Propagation characteristics of EM waves in free space, non-conducting and conducting media, conductors and dielectrics, depth of penetration, Poynting vector, Poynting theorem, Poynting theorem in complex form, Polarisation, Reflection of waves by a perfect conductor-normal and oblique incidence, Reflection and transmission of waves by a perfect dielectric-normal and oblique incidence, Brewster's angle, Total internal reflection, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, *(Lectures 10)*
5. **Wave Guides:** Wave guides, Derivation of field equations in rectangular wave guides, Transverse magnetic (TM) waves, Transverse Electric (TE) waves, Propagation characteristics of TM and TE waves, Lowest possible mode in TM and TE waves, Dominant mode, Evanescent mode, Degenerate mode, Transverse electromagnetic (TEM) waves and characteristics, Difference between Transmission lines and wave guides, Definition, function and properties of an antenna, Retarded vector potential . *(Lectures 10)*

**Text Books:**

1. Classical Electrodynamics: *S.P. Puri (Narosa Publishing House) 2011.*
2. Classical Electrodynamics*: J.D. Jackson, (New Age, New Delhi) 2009.*
3. Introduction to Electrodynamics: *D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2011.*

**Reference Books:**

1. Classical Electromagnetic Radiation: *J.B. Marion and M.A. Heald(Saunders College Publishing House) 2nd edition, 1995.*
2. Electromagnetic Fields, *Ronald K. Wangsness (John Wiley and Sons) 2nd edition,1986.*
3. Electromagnetic Field Theory Fundamentals: *Bhag Singh Guru and H.R. Hiziroglu*

| UC-MSPH-425-19 | Atomic and Molecular Physics | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level spectroscopy

**Course Objectives:** The aim and objective of the course on **Atomic and Molecular Physics** for the students of M.Sc. Physics is to equip them with the knowledge of Atomic, Rotational, Vibrational, Raman, and Electronic spectra.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Have the basic knowledge of Bohr's- Sommerfeld Quantum theory of hydrogen like atom |
| **CO2** | Understand classical/quantum description of electronic spectra of atom and molecules |
| **CO3** | Use microwave and Raman Spectroscopy for analysis of known molecules |
| **CO4** | Correlate infrared spectroscopic information of known molecules with their physical description |
| **CO5** | Understand Spin Resonance Spectroscopy with focus on NMR for molecular analysis |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 2 |
| **CO2** | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 |
| **CO3** | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 3 |
| **CO4** | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 3 |
| **CO5** | 2 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 3 |

**Detailed Syllabus:**

1. **Electronic Spectroscopy of Atoms:** Bohr-Sommerfeld model of atomic structure, Electronic wave function and atomic quantum numbers – hydrogen spectrum – orbital, spin and total angular momentum - fine structure of hydrogen atom – many electron spectrum: Lithium atom spectrum, angular momentum of many electrons – term symbols – the spectrum of helium and alkaline earths – equivalent and non-equivalent electrons –X-ray photoelectron spectroscopy. *(Lectures 8)*
2. **Electronic Spectroscopy of Molecules:** Diatomic molecular spectra: Born-Oppenheimer approximation – vibrational spectra and their progressions – Franck-Condon principle – dissociation energy and their products –rotational fine structure of electronic-vibration transition - molecular orbital theory – the spectrum of molecular hydrogen – change of shape on excitation – chemical analysis by electronic spectroscopy – reemission of energy – fundamentals of UV photoelectron spectroscopy. *(Lectures 9)*
3. **Microwave and Raman Spectroscopy:** Rotation of molecules and their spectra – diatomic molecules – intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules). *(Lectures 8)*
4. **Infra-red and Raman Spectroscopy:** The energy of diatomic molecules – Simple Harmonic Oscillator - the Anharmonic oscillator– the diatomic vibrating rotator – vibration-rotation spectrum of carbon monoxide –breakdown of Born-Oppenheimer approximation – the vibrations of polyatomic molecules –influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) – Raman activity of vibrations – vibrational Raman spectra – vibrations of Spherical top molecules. *(Lectures 8)*
5. **Spin Resonance Spectroscopy** Spin and magnetic field interaction – Larmor precession – relaxation time – spin-spin relaxation - spin–lattice relaxation - NMR chemical shift - coupling constants – coupling between nuclei – chemical analysis by NMR – NMR for nuclei other than hydrogen – ESR spectroscopy - fine structure in ESR. *(Lectures 8)*

**Text Books:**

1. Fundamentals of Molecular Spectroscopy: Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).
2. Physics of Atoms and Molecules: B. H. Bransden and C. J. Joachain.

**Reference Books:**

1. Physical method for Chemists (Second Edition):*Russell S. Drago (Saunders College Publishing).*
2. Introduction to Atomic Spectra: *H.E. White-Auckland McGraw Hill, 1924.*
3. Spectroscopy Vol. I, II & III: *Walker & Straughen*
4. Introduction to Molecular spectroscopy: *G.M. Barrow-Tokyo McGraw Hill, 1961.*
5. Spectra of diatomic molecules: *Herzberg-New York, 1944.*

| **UC-MSPH-426-19** | **Atomic, Nuclear, and Particle Physics Lab** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level atomic spectroscopy and nuclear physics

**Course Objectives:** The aim and objective of the lab on **Atomic, Nuclear and Particle Physics** is to expose the students of M.Sc. students to experimental techniques in atomic and nuclear physics so that they can verify some of the results obtained in theory and develop confidence to handle sophisticated equipment.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Acquire hands on experience of using particle detectors such as GM counter and Scintillation counter. |
| **CO2** | Handle oscilloscope for visualisation of various input and output signals. |
| **CO3** | Understand the basic of nuclear safely management. |
| **CO4** | Perform scientific experiments as well as accurately record and analyze the results of nuclear experiments. |
| **CO5** | Solve applied nuclear problems with critical thinking and analytical reasoning. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

**Note: Students are expected to perform atleast 10 experiments out of following list.**

1. Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer.
2. To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
3. Determination of Lande's factor of DPPH using Electron-spin resonance (E.S.R.) spectrometer.
4. Determination of ionization Potential of Lithium.
5. Analysis of pulse height of gamma ray spectra.
6. To study the characteristics of G.M. tube.
7. To verify the inverse square law using GM counter.
8. To determine the dead time of G.M. counter.
9. To study absorption of beta particles is matter using GM counter.
10. To study Gaussian distribution using G.M. counter.
11. To estimate the efficiency of GM detector for Gamma and Beta source.
12. Determination of Planck's constant using Photocell and interference filters.
13. Verification of Inverse square law using Photocell.
14. To study Gaussian distribution using scintillation counter.
15. To study absorption of gamma radiation by scintillation counter.
16. To estimate the efficiency of Scintillator counter.

**Text Books:**

1. Fundamentals of Molecular Spectroscopy: *Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).*
2. Physics of Atoms and Molecules: *B. H. Bransden and C. J. Joachain.*

**Reference Books:**

1. Physical method for Chemists (Second Edition): *Russell S. Drago (Saunders College Publishing).*
2. Introduction to Atomic Spectra: *H.E. White-Auckland McGraw Hill, 1924.*
3. Spectroscopy Vol. I, II & III: *Walker & Straughen*
4. Introduction to Molecular spectroscopy: *G.M. Barrow-Tokyo McGraw Hill, 1961.*
5. Spectra of diatomic molecules: *Herzberg-New York, 1944.*

| UC-MSPH-427-19 | Computational Physics Lab-II | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level numerical methods and C++

**Course Objectives:** The aim and objective of the lab on **Computational Physics-II** is to train the students of M.Sc. class in understanding numerical methods, the usage of high level language such as C++ language for simulation of results for different physics problems and graphic analysis of physical data, so that they are well equipped in the use of computer for solving physics related problems.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand and apply basics knowledge of numerical methods in solving the Physics problems. |
| **CO2** | Write programme with the C++ or any other high level language. |
| **CO3** | Learn use of graphical methods in data analysis and solving physics problems. |
| **CO4** | Solve physical problem, enabling development of critical thinking and analytical reasoning. |
| **CO5** | Apply computational physics in frontier areas of pure and applied research in physics and allied fields. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO3** | 1 | 2 | 1 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO5** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 1 |

**Detailed Syllabus:**

**Note: Students are expected to perform atleast 10 experiments out of following list using C++ and Gnuplot.**

1. Write a program to study graphically the EM oscillations in LCR circuit (use Runge-Kutta Method). Show the variation of (i) Charge vs Time and (ii) Current vs Time.
2. Study graphically the motion of falling spherical body under various effects of medium (viscous drag, buoyancy and air drag) using Euler method.
3. Study graphically the path of a projectile with air drag using FN method. Find the horizontal and maximum height in either case. Write your comments on the findings.
4. Study graphically the path of a projectile without air drag using FN method. Find the horizontal and maximum height in either case. Write your comments on the findings.
5. Study the motion of an artificial satellite.
6. Study the motion of 1-D harmonic oscillator (without and with damping effects). Draw graphs showing the relations: i) Velocity vs Time, ii) Acceleration vs Time iii) Position vs Time, also compare the numerical and analytical results.
7. Study the motion of two coupled harmonic oscillators. Draw graphs showing the relations: i) Velocity vs Time, ii) Acceleration vs Time iii) Position vs Time, also compare the numerical and analytical results.
8. To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method.
9. Study the motion of a charged particle in uniform electric field.
10. Study the motion of a charged particle in uniform Magnetic field.
11. Study the motion of a charged particle in combined uniform electric and magnetic fields.
12. Use Monte Carlo techniques to simulate phenomenon of Nuclear Radioactivity. Do the cases in which the daughter nuclei are also unstable with half life greater/lesser than the parent nucleus.
13. Use Monte Carlo techniques to simulate phenomenon to determine solid angle in a given geometry.
14. Use Monte Carlo techniques to simulate phenomenon to simulate attenuation of gamma rays/neutron in an absorber.
15. Use Monte Carlo techniques to simulate phenomenon to solve multiple integrals and compare results with Simpson's method.

16. To study phase trajectory of a Chaotic Pendulum.
17. To study convection in fluids using Lorenz system.

**Text Books:**

1. Numerical Recipes in C++ The Art of Scientific Computing, William H. Press, Saul, A.Teukolsky, William T. Vetterling, and Brian P. Flannery, (Cambridge), 2nd ed. 2001.
2. A First Course in Computational Physics: P.L. DeVries (John Wiley) 2000.

**Reference Books:**

1. An introduction to Computational Physics: Tao Pang (Cambridge), 2nd ed. 2006.
2. Computer Applications in Physics: S. Chandra (Narosa), 2006.
3. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age), 2005.
4. Object Oriented Programming with C++: Balagurusamy, (Tata McGraw Hill), 5th ed. 2011.

| **UC-MSPH-531-19** | **Condensed Matter Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level solid state physics

**Course Objectives:** The aim and objective of the course on **Condensed Matter Physics** is to expose the students of M.Sc. class to the topics like elastic constants, lattice vibrations, dielectric properties, energy band theory and transport theory so that they are equipped with the techniques used in investigating these aspects of the matter in condensed phase.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Gain in-depth knowledge about the formation of various crystal structure via performing calculations on their elemental parameters. |
| **CO2** | Differentiate between various lattice types based on their lattice dynamics and then explain thermal properties of crystalline solids. |
| **CO3** | Understand the electron motion in periodic solids and origin of energy bands in semiconductors. |
| **CO4** | To explain the basic transport theory for understanding the transport phenomenon in solids |
| **CO5** | Using various models of molecular polarizability, understand the dielectric properties of insulators. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO5** | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Crystal binding and Elastic constants:** Binding in solids; Cohesive energy, Crystals of Inert gases, ionic crystal, Covalent Crystals, Analysis of elastic strains: dilation, stress components; Elastic Compliance and Stiffness: elastic constants, elastic waves in cubic crystals. (Lectures 6)
2. **Lattice Dynamics and Thermal Properties:** Vibrations of crystal with monatomic and two atom per primitive Basis; Quantization of Elastic waves, Phonon momentum; Inelastic scattering by phonons, Phonon Heat Capacity, Planck Distribution, normal modes; Density of states, Debye T2 model; Einstein Model; anharmonic crystal interactions; thermal conductivity expansion. (Lectures 9)
3. **Energy Band Theory:** Electrons in a periodic potential: Bloch theorem, Nearly free electron model; Kronig Penney Model; Electron in a periodic potential; tight binding method; Wigner-Seitz Method Semiconductor Crystals, Band theory of pure and doped semiconductors; effective mass elementary idea of semiconductor superlattices. (Lectures 9)
4. **Transport Theory:** Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magneto resistance. (Lectures 8)
5. **Dielectrics and Ferro Electrics:** Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity; Dipole theory of ferroelectricity; thermodynamics of ferroelectric transition. (Lectures 8)

**Text Books:**

1. Introduction to Solid State Physics: *C. Kittel (Wiley, New York), 8th ed. 2005.*
2. Quantum Theory of Solids: *C. Kittel (Wiley, New York) 1987.*

**Reference Books:**

1. Principles of the Theory of Solids: *J. Ziman (Cambridge University Press) 1971*
2. Solid State Theory: *Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.*
3. Liquid Crystals: *S. Chandrasekhar (Cambridge University), 2nd ed. 1991.*

| **UC-MSPH-532-19** | **Nuclear Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level physics

**Course Objectives:** The aim and objective of the course on **Nuclear Physics** is to familiarize the students of M.Sc. class to the basic aspects of Nuclear Physics like static properties of nuclei, radioactive decays, nuclear forces, nuclear models, and nuclear reactions so that they are equipped with the techniques used in studying these things.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand and compare nuclear models and explain nuclear properties using nuclear models. |
| **CO2** | Understand structure and static properties of nuclei. |
| **CO3** | Analyse various decay mode of nucleus. |
| **CO4** | Use nucleon-nucleon scattering and deuteron problem to explain nature of nuclear forces. |
| **CO5** | Describe various types of nuclear reactions and their properties. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Static properties of nucleus:** Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfine structure. *(Lectures 5)*

2. **Nuclear forces:** Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, single and triplet potentials, meson theory of nuclear forces. *(Lectures 10)*

3. **Nuclear decay:** Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Neutrino, detection of neutrinos, Multipolarity of gamma transitions, internal conversion process. *(Lectures 10)*

4. **Nuclear Models:** Liquid drop model, Binding energy; fission and fusion, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Application of Shell Model like Angular momenta and parities of nuclear ground states, Collective model-nuclear vibrations spectra and rotational spectra. *(Lectures 8)*

5. **Nuclear reactions:** Nuclear reactions and cross-sections, Resonance, Breit- Wigner dispersion formula for l=0 and higher values, compound nucleus, Direct reactions, Transfer reactions. *(Lectures 7)*

**Text Books:**
1. Nuclear Physics*: Irving Kaplan (Narosa), 2001.*
2. Theory of Nuclear Structure: *R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.*
3. Handbook of Nuclear Physics: *S.N. Ghoshal, S. Chand Publishing* (1994).

**Reference Books:**
1. Basic Ideas and Concepts in Nuclear Physics*: K. Hyde (Institute of Physics) 2004.*
2. Nuclear physics: Experimental and Theoretical, *H.S. Hans (New Academic Science) 2$^{nd}$ ed (2011).*

| UC-MSPH-533-19 | Particle Physics | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|
| **Pre-requisite:** course on Quantum Mechanics and Quantum field Theory | | | |
| The aim and objective of the course on **Particle Physics** is to introduce the M.Sc. students to the invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Overview the particle spectrum, their interaction and major historical and latest developments. | | |
| **CO2** | Understand the implications of various invariance principles and symmetry properties in particle physics. | | |
| **CO3** | Master relativistic kinematics for computations of outcome of various reactions and decay processes. | | |
| **CO4** | Properties of baryons and mesons in terms of naive nonrelativistic quark model. | | |
| **CO5** | Weak interaction in quarks and leptons and how that this is responsible for β decay. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 3 |
| **CO2** | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 3 |
| **CO3** | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | - | 1 |
| **CO4** | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 3 | 2 | - | 2 |

**Detailed Syllabus:**

1. **Introduction:** Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions - electromagnetic, weak, strong and gravitational, units. *(Lectures 7)*
2. **Invariance Principles and Conservation Laws:** Invariance in classical mechanics and quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay, Time reversal invariance, CPT theorem. *(Lectures 7)*
3. **Hadron-Hadron Interactions:** Cross section and decay rates, Pion spin, Isospin, Two nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy. *(Lectures 7)*
4. **Relativistic Kinematics and Phase Space:** Introduction to relativistic kinematics, particle reactions, Lorentz invariant phase space, two-body and three-body phase space, dalitz plots, K-2p-decay, t-θ puzzle, dalitz plots for dissimilar particles, Breit-Wigner resonance formula, Mandelstem variables. *(Lectures 7)*
5. **Static Quark Model of Hadrons:** The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combination. *(Lectures 7)*
6. **Weak Interactions:** Classification of weak interactions, Fermi theory, Parity non conservation in ß-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination. *(Lectures 7)*

**Text Books:**

1. Introduction to High Energy Physics: D.H. Perkins (Cambridge University Press), 2000.
2. Introduction to Quarks and Partons: F.E. Close (Academic Press, London), 1979.
3. Introduction to Particle Physics: M.P. Khanna (Prentice Hall of India, New Delhi), 2004.

**Reference Books:**

1. An Introductory Course of Particle Physics: Palash Pal (CRC Press).
2. Elementary Particles: I.S. Hughes (Cambridge University Press), 3rd ed. 1991.
3. Gauge Theory of Elementary Particle Physics: T.P Cheng & L.F. Li (Oxford).
4. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).
5. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.
6. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).

# Elective Subject -I

| **UC-MSPH-534-19** | **Fibre Optics and Non-linear optics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level optics and Lasers

**Course Objectives: Course Objectives**: The aim and objective of the course on **Fibre Optics and Nonlinear Optics** is to expose the M.Sc. students to the basics of the challenging research field of optical fibres and their use in nonlinear optics.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the structure of optical fiber and describe properties of optical fibers. |
| **CO2** | Identify and compare the various processes of fibers fabrication |
| **CO3** | Describe the optics of anisotropic media |
| **CO4** | Analyze the electro-optic and acousto-optic effects in fibers |
| **CO5** | analyze non-linear effects in optical fibers. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | - | 1 | - | 1 | - | 1 | - | 3 | - | 1 |
| **CO2** | 3 | 2 | 1 | 1 | 1 | 1 | - | 1 | - | 3 | - | 1 |
| **CO3** | 2 | 2 | - | 1 | - | 1 | - | 1 | - | 3 | - | 1 |
| **CO4** | 3 | 2 | 1 | 1 | 1 | - | - | 1 | - | 3 | - | 1 |
| **CO5** | 3 | 2 | 1 | 1 | 1 | - | - | 1 | - | 3 | - | 1 |

**Detailed Syllabus:**

1. **Optical fibre and its properties:** Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types. *(Lectures 7)*

2. **Fiber fabrication and cable design:** Fibre fabrication, mass production of fiber, comparison of the processes, fiber drawing process, coatings, cable design requirements, typical cable design, testing. *(Lectures 5)*

3. **Optics of anisotropic media:** Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/ polarizer combinations. *(Lectures 10)*

4. **Electro-optic and acousto-optic effects and modulation of light beams**: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro optic modulation, electro optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a logitudinal acoustic wave in isotropic medium, Raman-Nath diffraction, Raman-Nath acousto-optic modulator. *(Lectures 10)*

5. **Non-linear optics/processes**: Introduction, anharmonic potentials and nonlinear polarization, non-linear susceptibilities and mixing coefficients, parametric and other nonlinear processes, macroscopic and microscopic susceptibilities. *(Lectures 8)*

**Text Books:**

1. The Elements of Fibre Optics: *S.L.Wymer and Meardon (Regents/Prentice Hall), 1992.*

**Reference Books:**

*1.* Lasers and Electro-Optics: *C.C. Davis (Cambridge University Press), 1996.*
2. Optical Electronics: *Gathak & Thyagarajan (Cambridge Univ. Press), 1989.*
3. The Elements of Non-linear Optics: *P.N. Butcher & D. Cotter (Cambridge University Press), 1991.*

**Elective Subject -I**

| **UC-MSPH-535-19** | **Radiation Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|
| **Pre-requisite:** Understanding of graduate level nuclear physics | | | |
| **Course Objectives:** The aim and objective of the course on **Radiation Physics** is to expose the students of M.Sc. class to the relatively advanced topics Radiation Physics and nuclear reactions so that they understand the details of the underlying aspects and can use the techniques if they decide to be radiation or nuclear physicists in their career. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Understand various modes of interaction of electromagnetic radiations and charged particles with matter. | | |
| **CO2** | Distinguish various types of radiations based on their interaction with matter. | | |
| **CO3** | Learn and understand about different detectors. | | |
| **CO4** | Use different analytical technique such as XRF, PIXE, neutron activation analysis and electron spin resonance spectroscopy. | | |
| **CO5** | Design experiments to analyze effects of radiation on various objects. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| **CO2** | 1 | 1 | 1 | - | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Interaction of electromagnetic radiations with Matter:** Different photon interaction processes viz. photoelectric effect, Compton scattering and pair production. Minor interaction processes, Energy and Z dependence of partial photon interaction processes. Attenuation coefficients, Broad and narrow beam geometries. Multiple scattering.
*(Lectures 10)*

2. **Interaction of charged particles with Matter:** Elastic and inelastic collisions with electrons and atomic nucleus. Energy loss of heavy charged particles. Range-energy relationships, Straggling. Radiative collisions of electrons with atomic nucleus.
*(Lectures 10)*
3. **Nuclear Detectors and Instrumentation:** General characteristics of detectors, Gas filled detectors, Organic and inorganic scintillation detectors, Semi-conductor detectors [Si(Li), Ge(Li) HPGe]. Room temperature detectors, Gamma ray spectrometers. Gamma ray spectrometry with NaI(Tl) scintillation and semiconductor detectors.
*(Lectures 10)*

4. **Analytical Techniques:** Principle, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis (NAA) techniques. Theory, instrumentation and applications of electron spin resonance spectroscopy (ESR). Experimental techniques and applications of Rutherford backscattering. Applications of elemental analysis and nuclear medicine.
*(Lectures 10)*

**Text Books:**
1. The Atomic Nucleus: R.D. Evans, Tata Mc Graw Hill, New Delhi.
2. Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy, New Age, International, New Delhi.

**Reference Books:**
1. Radiation Detection and Measurements: G. F. Knoll, Wiley & Sons, New Delhi.
2. Introductory Nuclear Physics: K. S. Krane, Wiley & Sons, New Delhi.
3. An Introduction to X-ray Spectrometry: Ron Jenkin, Wiley.
4. Techniques for Nuclear and Particle Physics Experiments: W. R. Leo, Narosa Publishing House, New Delhi.
5. Introduction to experimental Nuclear Physics: R.M. Singru, Wiley & Sons, New Delhi

**Elective Subject -I**

| **UC-MSPH-536-19** | **Nonlinear Dynamics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level physics

**Course Objectives:** The aim and objective of the course on **Nonlinear Dynamics** is to familiarize the M.Sc. students with the basics of the recently emerging research field of dynamics of nonlinear Hamiltonian systems.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand basic knowledge of nonlinear dynamics and phenomenology of chaos. |
| **CO2** | Apply the tools of dynamical systems theory in context to models. |
| **CO3** | Learn skills by solving problems on solving nonlinear problems using numerical methods. |
| **CO4** | Understand Hamilton approach for describing various physical system. |
| **CO5** | Quantify classical chaos and Quantum chaos. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | - | 1 | - | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 |
| **CO4** | 2 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 |
| **CO5** | 2 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 |

**Detailed Syllabus:**

1. **Phenomenology of Chaos**: Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and size scaling, self similarity, models and universality of chaos. *(Lectures 8)*

2. **Dynamics in State Space:** State space, autonomous and nonautonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence. *(Lectures 10)*

3. **Hamiltonian System**: Non-integrable systems, KAM theorem and period doubling, standard map. Applications of Hamiltonian Dynamics, chaos and stochasticity. *(Lectures 8)*

4. **Quantifying Chaos**: Time series, Lyapunov exponents. Invariant measure, Kolmogorov - Sinai entropy. Fractal dimension, Statistical mechanics and thermodynamic formalism. *(Lectures 7)*

5. **Quantum Chaos**: Quantum Mechanical analogies of chaotic behaviour, Distribution of energy eigenvalue spacing, chaos and semi-classical approach to quantum mechanics. *(Lectures 7)*

**Text Books:**
1. Chaos and Non Linear Dynamics: R.C. Hilborn (Oxford Univ. Press), 2001.

**Reference Books:**
1. Chaos in Dynamical Systems: E. Ott (Cambridge Univ. Press), 2001.
2. Applied Nonlinear Dynamics: A.H. Nayfeh and B. Balachandran (Wiley), 1995.
3. Chaos in Classical and Quantum Mechanics: M.C. Gutzwiller (Springer-Verlag), 1990.

## Elective Subject -II

| **UC-MSPH-537-19** | **Plasma Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** Course on Electrodynamics

**Course Objectives:** The aim and objective of the course on **Plasma Physics** is to expose the M.Sc. students to the basics of the challenging research field Plasma physics.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the origin of plasma, conditions of plasma formation and properties of plasma. |
| **CO2** | Distinguish between the single particle approach, fluid approach and kinetic statistical approach to describe different plasma phenomena. |
| **CO3** | Classify propagation of electrostatic and electromagnetic waves in magnetized and non-magnetized plasmas |
| **CO4** | Describe the basic transport phenomena such as plasma resistivity, diffusion and mobility for both magnetized and non-magnetized plasmas. |
| **CO5** | Formulate the conditions for describing a plasma to be in a state of thermodynamic equilibrium, or non-equilibrium, and analyze the stability of this equilibrium. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO2** | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO4** | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO5** | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 |

**Detailed Syllabus:**

1. **Introduction:** Plasma State, elementary concepts and definitions of temperature and other parameters, occurrence and importance of plasma for various applications, Production of Plasma in the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of discharge. *(Lectures 8)*

2. **Plasma diagnostics:** Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts. *(Lectures 5)*

3. **Single particle orbit theory:** Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves. *(Lectures 8)*

4. **Fluid description of plasmas:** distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations. dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion- acoustic waves, Alfven waves, Magnetosonic waves. *(Lectures 10)*

5. **Stability of fluid plasma:** The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, plasma supported against gravity by magnetic field, energy principle. microscopic equations for my body system: Statistical equations for many body systems, Vlasov equation and its properties, drift kinetic equation and its properties. *(Lectures 7)*

**Text Books:**

1. Introduction to Plasma Physics, *F.F. Chen*

**Reference Books:**

1. Principles of Plasma Physics, *Krall and Trievelpice*
2. Introduction to Plasma Theory, *D.R. Nicholson*
3. The Plasma State, *J.L. Shohet*
4. Introduction to Plasma Physics, *M. Uman*
5. Principles of Plasma Diagnostic, *I.H. Hutchinson*

**Elective Subject-II**

| UC-MSPH-538-19 | Structures, Spectra and Properties of Biomolecules | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level chemistry and physics

**Course Objectives:** The aim and objective of the course on **Structures, Spectra and properties of Biomolecules** is to familiarize the M.Sc. students with the basics of the recently emerging research field of dynamics of Structures, Spectra and properties of Biomolecules.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Describe various structural and chemical bonding aspects of Biomolecules. |
| **CO2** | Understand structure and theoretical techniques and their application to Biomolecules. |
| **CO3** | Understand use of various spectroscopic techniques and their application to the Biomolecules. |
| **CO4** | Understand the structure-Function relationship and modeling of biomolecules. |
| **CO5** | Outline and correlate for providing solution to interdisciplinary problem. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 2 | 1 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 2 | 1 | 2 | 1 | 2 | 2 | - | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 1 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 |

**Detailed Syllabus:**

1. **Structure Aspects of Biomolecule:** Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Structure of Polysaccharides. *(Lectures10)*

2. **Theoretical Techniques and Their Application to Biomolecules:** Hard Sphere Approximation, Ramachandran Plot, Potential Energy Surface, Outline of Molecular Mechanics Method, Brief ideas about Semi-empirical and Ab initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their uses. *(Lectures 10)*

3. **Spectroscopic Techniques and their Application to Biomolecules:** Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR spectroscopy, Photoacoustic Spectroscopy, Photo-biological Aspects of Nucleic Acids. *(Lectures 10)*

4. **Structure-Function Relationship and Modeling:** Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model. *(Lectures 10)*

**Text Books:**

1. *Srinivasan & Pattabhi:* Structure Aspects of Biomolecules.

**Reference Books:**

1. *Govil & Hosur*: Conformations of Biological Molecules
2. *Price:* Basic Molecular Biology
3. *Pullman:* Quantum Mechanics of Molecular Conformations
4. *Lehninger:* Biochemistry
5. Mehler & Cordes: Biological Chemistry
6. *Smith and Hanawait:* molecular Photobiology, Inactivation and Recovery

**Elective Subject - II**

| **UC-MSPH-539-19** | **Science of Renewable source of Energy** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|
| **Pre-requisite:** Understanding of graduate level semiconductor physics | | | |
| **Course Objectives:** The aim and objective of the course on **Science of renewable Energy Sources** is to expose the M.Sc. students to the basics of the alternative energy sources like solar energy, hydrogen energy, etc. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Understand the energy demand of world & distinguish between traditional and alternative form of energy. | | |
| **CO2** | Describe the concept of solar energy radiation and thermal applications. | | |
| **CO3** | Analyze making of solar cell and its types. | | |
| **CO4** | Identify hydrogen as energy source, its storage and transportation methods. | | |
| **CO5** | Compare wind energy, wave energy and ocean thermal energy conversion. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | - | 1 | - | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| **CO3** | 3 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO4** | 2 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |
| **CO5** | 2 | 2 | - | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 |

**Detailed Syllabus:**

1. **Introduction**: Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources. *(Lectures 8)*

2. **Solar Energy**: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, Principal of working of solar cell, Performance characteristics of solar cell. Types of solar cell, crystalline silicon solar cell, Thin film solar cell, multijunction solar cell, Elementary ideas of perovskite solar cell, dye synthesized solar cell and Tandem solar cell, PV solar cell, module array, and panel, Applications. *(Lectures 11)*

3. **Hydrogen Energy**: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells. *(Lectures 10)*

4. **Other sources**: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC, basic idea about biogas, biofuel, and biodiesel. *(Lectures 8)*

**Text Books:**

1. Solar Energy: *S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.*

**Reference Books:**

1. Solar Cell Devices: *Fonash (Academic Press, New York),2010.*
2. Fundamentals of Solar Cells, Photovoltaic Solar Energy: *Fahrenbruch and Bube (Springer, Berlin), 1982.*
3. Photoelectrochemical Solar Cells: *Chandra (New Age, New Delhi).*

| UC-MSPH-540-19 | Condensed Matter Physics Lab | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|

**Pre-requisite:** Understanding of graduate level solid state physics experiments

**Course Objectives:** The aim and objective of the courses on **Condensed Matter Physics Lab** is to train the students of M.Sc. class to advanced experimental techniques in condensed matter physics so that they can investigate various relevant aspects and are confident to handle sophisticated equipment and analyze the data.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Measure conductivity, resistivity and thermo-dynamical properties of solids. |
| **CO2** | Measure magnetic properties and magnetic behavior of magnetic materials. |
| **CO3** | Describe the lattice dynamics of simple lattice structures in terms of dispersion relations. |
| **CO4** | Design and carry out scientific experiments as well as accurately record and analyze the results of experiments. |
| **CO5** | Solve problem with critical thinking and analytical reasoning. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 1 | 1 | 1 | - | - | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 1 | 1 | 1 | 1 | - | - | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 1 | 1 | 1 | 1 | 1 | - | - | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

**Note: Students are expected to perform atleast ten experiments out of following list.**

1. To study temperature dependence of conductivity of a given semiconductor crystal using four probe method.
2. Verification of curie-weiss law for the electrical susceptibility of a ferroelectric material.
3. To determine charge carrier density and Hall coefficient by Hall effect.
4. To determine magnetic susceptibility of material using Quink 's tube method.
5. To determine energy gap and resistivity of the semiconductor using four probe method.
6. To study the B-H loop characteristics.
7. To determine dielectric constant of a material with Microwave set up.
8. To measure the Curie temperature of a given PZT sample.
9. To measure the velocity of ultrasonic wave in liquids.
10. To study dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
11. To study the properties of crystals using X-Ray Apparatus.

**Text Books:**

1. Introduction to Solid State Physics: *C. Kittel (Wiley, New York), 8th ed. 2005.*
2. Quantum Theory of Solids: *C. Kittel (Wiley, New York) 1987.*

**Reference Books:**

1. Principles of the Theory of Solids: *J. Ziman (Cambridge University Press) 1971*
2. Solid State Theory: *Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.*
3. Liquid Crystals: *S. Chandrasekhar (Cambridge University), 2nd ed. 1991.*

## Elective Subject -III

| | | | |
|---|---|---|---|
| **UC-MSPH-541-19** | **Physics of Nanomaterials** | **L-3, T-1, P-0** | **4 Credits** |

**Pre-requisite:** Condensed matter physics

**Course Objectives:** The aim and objective of the course on **Physics of Nano-materials** is to familiarize the students of M.Sc. to the various aspects related to preparation, characterization and study of different properties of nanomaterials so that they can pursue this emerging research field as career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Apply the knowledge on free electron theory to the band structure of metals, insulators, and semiconductors. |
| **CO2** | Acquire knowledge of basic approaches to synthesize the inorganic nanoparticles |
| **CO3** | Describe the use of unique optical properties of nanoscale metallic structures for analytical and biological applications |
| **CO4** | Understand the physical and chemical properties of carbon nanotubes and nanostructured mesoporous materials. |
| **CO5** | Determine the structure-property relationships in nanomaterials as well as the concepts, not applicable at larger length scales. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | - | 1 | 2 | 1 | 1 | 2 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 2 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 2 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 2 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | 2 | 2 | 3 |

**Detailed Syllabus:**

1. **Introductory Aspects:** Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state in one, two, and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials. *(Lectures 8)*

2. **Synthesis of Nanomaterials:** Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling. *(Lectures 8)*

3. **General Characterization Techniques:** Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy. *(Lectures 8)*

4. **Quantum Dots:** Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots. *(Lectures 8)*

5. **Carbon based Nanomaterials:** Synthesis, structural, and electronics properties of fullerenes, carbon nanotubes, and graphene, Functionalisation of carbon Nanomaterials, Applications of carbon based Nanomaterials. *(Lectures 8)*

**Text Books:**

1. Nanotechnology-Molecularly Designed Materials: *G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.*
2. Nanotechnology Molecular Speculations on Global Abundance: *B.C. Crandall (MIT Press), 1996*.

**Reference Books:**

1. Quantum Dot Heterostructures: *D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley),1998*.
2. Introduction to Nanotechnology, Charles P. Poole Jr., Frank J. Owens, Wiley Student edition, John Wiley & Sons Inc. Publishes (2003).
3. Nanotechnology: A gentle introduction to the next Big Idea, Mark Ratner & Daniel Ratner, LPE, Pearson Education (2002).
4. Nanostructures and Nanomaterials: Synthesis: *Properties and Applications, G. Cao, Imperial College Press 2nd edition (2011).*
5. NANO: The Essentials "Understanding Nanoscience and Nanotechnology": *T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi (2007).*
6. Advanced Micro- & Nanosystems, CMOS-MEMS: *O. Brand and G K. Fedder, Wiley-VCH (2008)*
7. Nanophotonics: *Paras N. Prasad, Wiley- Interscience (2004).*
8. Biomedical Nanotechnology: *NH Malsch, Taylor & Francis Group (2005).*

**Elective Subject -III**

| | | | |
|---|---|---|---|
| **UC-MSPH-542-19** | **Experimental Techniques in Nuclear and Particle Physics** | **L-3, T-1, P-0** | **4 Credits** |

**Pre-requisite:** Course on Nuclear and Particle Physics

**Course Objectives:** The aim and objective of the course on **Experimental Techniques in Nuclear and Particle Physics** is to expose the students of M.Sc. students to experimental aspects of different equipment and methods used in the fields of nuclear physics and particle physics.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Understand various experimental techniques for describing interaction of radiations with matter. |
| **CO2** | Use error analysis for experimental data. |
| **CO3** | Knowledge about the different types of the radiation detectors. |
| **CO4** | Apply the knowledge of detectors for various applications |
| **CO5** | Equipped with the basic knowledge about the experimental methods used in the various laboratories across the world. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | 2 | - | 1 | - | - | 1 | - | 1 | 1 | 1 |
| **CO2** | - | - | - | 3 | - | - | - | 3 | 1 | 1 | 1 | 1 |
| **CO3** | - | - | 1 | 2 | 3 | - | 1 | 3 | 2 | 2 | 2 | 2 |
| **CO4** | - | - | 1 | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | - | - | 1 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |

**Detailed Syllabus:**

1. **Detection of radiations:** Interaction of gamma-rays, electrons, heavy charged particles, neutrons, neutrinos and other particles with matter (Qualitative description only) . General properties of Radiation detectors, energy resolution, detection efficiency and dead time, Error propagation in experimental data. *(Lectures 8)*

2. **Detectors:** Introduction to Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber. Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes, Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, Pulse height spectrum. *(Lectures 16)*

3. **Applications of Detectors:** Description of electron and gamma ray spectrum from detector, semiconductor detectors in X- and gamma-ray spectroscopy, Semiconductor detectors for charged particle spectroscopy and particle identification. *(Lectures 8)*

4. **Experimental methods:** Large gamma and charge particle detector arrays, heavy-ion reaction analysers, production of radioactive ion beams. Detector systems for high energy experiments: Collider physics (brief account), Particle Accelerators (brief account), Modern Hybrid experiments- CMS. *(Lectures 8)*

**Text Books:**

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.

**Reference Books:**

1. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
2. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001.
3. Detectors for particle radiation by Konrad Kleinknecht (Cambridge University Press), 1999.

Elective Subject -III

| **UC-MSPH-543-19** | **Superconductivity and Low Temperature Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|
| **Pre-requisite:** course in Condensed Matter Physics | | | |
| **Course Objectives:** The objective of the course on Superconductivity and Low Temperature Physics is to build fundamental as well as advanced understanding in the field of superconductivity. Students will not only learn theoretical aspects but also acquainted with latest trends in the experimental techniques as well. Low temperature is one of the most versatile and important tool to explore rich physics of superconductivity. With latest technology the lowest achievable temperature now is close to few μK. Students will also be introduced to the theoretical background of low temperature techniques as well as the high-Tc superconductors. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Theoretical understanding of the concept of superconductivity. | | |
| **CO2** | Correlate observed experimental properties of superconductors with origin of superconductivity. | | |
| **CO3** | Describe appropriate theoretical model for describing behavior of superconductors. | | |
| **CO4** | Provide exposure to High Tc class of superconductors and theoretical understanding of low temperature techniques. | | |
| **CO5** | Provide exposure about the experimental techniques for measurement of superconductivity. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 2 |
| **CO3** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 3 | 2 |
| **CO4** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| **CO5** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 2 |

**Detailed Syllabus:**

1. **Superconductivity:** Introduction, Thermodynamics, The London Equations, penetration depth, Superconductors in magnetic field, Ginzberg-Landau Theory, Type I and II superconductors, BCS theory, second quantization, Cooper Pairing, energy gap Tunnelling, Josephson effects and SIS tunneling. *(Lectures 10)*

2. **Preparation and measurement techniques:** Single crystal growth: Optical image furnace, seeded melt growth, Thin film deposition: Pulsed laser deposition, sputtering, Resistivity measurements, magnetic measurements, Point contact spectroscopy, scanning tunneling microscopy and spectroscopy. *(Lectures 10)*

3. **Cryogenics:** Thermal and electrical properties of different materials at low temperatures, Cooling methods above 1K, Joule-ThomPOn, Gifford-McMohan, Evaporation cooling, Liquefication of Helium, Cooling methods below 1K, dilution refrigeration, adiabatic demagnetisation. *(Lectures 10)*

4. **Introduction to high-Tc superconductors:** Discovery of high-Tc superconductors, Mechanisms of superconductivity in high-Tc superconductors, Introduction to high-Tc superconducting compound like YBCO, Synthesis, Structure and properties, Electronics and applications. *(Lectures 10)*

**Text Books:**

1. Introduction to superconductivity: Michael Tinkham, Courier Corporation, 2004.

**Reference Books:**

1. Introduction to superconductivity: *A.C. Rose-Innes and E.H. Rhoderick,* Pergamon Press, 2004.
2. Experimental techniques in low temperature physics: *G.K. White and P.J. Meeson*, Oxford Univ. Press, 2001.
3. Experimental low temperature physics: *A. Kent*, MacMillan Press, 1992.
4. The theory of superconductivity in high-TC Cuprates: *P.W. Anderson*, Princeton Series Publications.

## Elective Subject -IV

| **UC-MSPH-544-19** | **Advanced Condensed Matter Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|

**Pre-requisite:** course on Condensed Matter Physics

**Course Objectives:** The objective of the course on **Advanced Condensed Matter Physics** is to familiarize the M.Sc. students with relatively advanced topics like optical properties, magnetism, superconductivity, magnetic resonance techniques and disordered solids so that they are confident to use the relevant techniques in their later career.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Comprehend and describe the Optical properties of solids employing macroscopic theories. |
| **CO2** | Explain various types of magnetic phenomenon in solids, underlying physics, and correlation with the applications. |
| **CO3** | Understand and realize the use of NMR methods for describing solids. |
| **CO4** | Interpret the phenomena, behavior and applications of superconductors. |
| **CO5** | Figure out and perceive the effect of deformation and disorder on the behavior of solids |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 3 |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |

**Detailed Syllabus:**

1. **Optical Properties:** Macroscopic theory; Reflectance and Transmittance of a slab; generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect in crystals; interband transitions. (Lectures 8)

2. **Magnetism:** Dia and para-magnetism in materials; Langevin theory of diamagnetism, quantum theory of diamagnetism and paramagnetism, Exchange interaction. Heisenberg Hamiltonian; Hubbard model; mean field theory; Ferro-, ferri- and antiferromagnetism; Magnons: spin waves, thermal excitation of magnons; Bloch T2/1 law. (Lectures 8)

3. **Nuclear Magnetic Resonance in Solids:** Origin of NMR in solids– equations of motion, line width, motional narrowing, Knight shift. (Lectures 8)

4. **Superconductivity:** Experimental Survey; Basic phenomenology; Vortex state of a Type II superconductors; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Tunneling Experiments; High Tc superconductors; Ginzburg-Landau theory; Greens functions at zero temperature; Applications of Greens functions to superconductivity. (Lectures 8)

5. **Disordered Solids:** Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, Glasses, Amorphous semiconductors and Ferromagnets, Heat capacity and Thermal conductivity of amorphous solids; Quasicrystals. (Lectures 8)

**Text Books:**

1. Introduction to Solid State Physics: C. Kittel (Wiley, New York) 2005.
2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

**Reference Books:**

1. Principles of the Theory of Solids: *J. Ziman (Cambridge University Press) 1971*.
2. Solid State Physics: *H. Ibach and H. Luth (Springer, Berlin), 3rd. ed. 2001.*
3. A Quantum Approach to Solids: *P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970*.
4. Intermediate Quantum Theory of Solids: *A.O.E. Animalu (East-West Press, New Delhi),1991.*
5. Solid State Physics : *Ashcroft and Mermin (Reinhert& Winston, Berlin), 1976.*

**Elective Subject -IV**

| **UC-MSPH-545-19** | **Advanced Particle Physics** | **L-3, T-1, P-0** | **4 Credits** |
|---|---|---|---|
| **Pre-requisite:** course on particle physics | | | |
| **Course Objectives:** The objective of the course on **Advanced Particle Physics** is to expose the students of M.Sc. class to the relatively advanced topics related to symmetry breaking in quantum field theory, standard model of particle physics, QCD and quark model, and various unification schemes so that they understand these aspects properly and are well equipped to pursue a career in high energy physics. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Understand various global and local gauge symmetries of system, invariance of action, symmetry breaking, and Higgs mechanism. | | |
| **CO2** | Need for standard model of particle physics and its limitations and the properties of QCD. | | |
| **CO3** | Define the problem of divergencies in quantum field theories and the renormalisation methods. | | |
| **CO4** | Asymptotic freedom and infrared slavery of the running coupling constant in non-abelian gauge theory of strong interactions -QCD. | | |
| **CO5** | Given exposure about the physics beyond the Standard Model. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 1 | 1 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| **CO3** | 1 | 2 | 1 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | 2 |
| **CO4** | 1 | 1 | 2 | 1 | 2 | 2 | 2 | - | 1 | 2 | 1 | 2 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 2 | 2 | - | 2 | 2 | 3 | 2 |

**Detailed Syllabus:**

1. **Symmetries and Symmetry Breaking in QFT:** Continuous groups: Lorentz group SO(1,2) and its representations, Unitary groups and Orthogonal groups and their representations, Discrete symmetries: Parity, Charge Conjugation and Time reversal Invariance, CP, CPT. (Lectures 10)

2. **Global and Local invariances of the Action:** Approximate symmetries, Noethers theorem, Spontaneous breaking of symmetry and Goldstone theorem, Higgs mechanism, Abelian and Non-Abelian gauge fields, Lagrangian and gauge invariant coupling to matter fields. (Lectures 10)

3. **Standard Model of Particle Physics:** SU(2) x SU(1) x U(1) gauge theory, Coupling to Higgs and Matter fields of 2 generations, Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix, Low energy Electroweak effective theory, Elementary electroweak scattering processes. (Lectures 10)

4. **QCD and quark model:** Asymptotic freedom and Infrared slavery, confinement hypothesis, Approximate flavor symmetries of the QCD lagrangian, Classification of hadrons by flavor symmetry: SU(1) and SU(2) multiplets of Mesons and Baryons, Chiral symmetry and chiral symmetry breaking, Sigma model, Parton model and Deep inelastic scattering structure functions. (Lectures 10)

**Text Books:**

1. Gauge Theory of Elementary Particle Physics: T.P Cheng & L.F. Li (Oxford).
2. An Introductory Course of Particle Physics: Palash Pal (CRC Press).

**Reference Books:**

1. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.
2. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).
3. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).

**Elective Subject -IV**

| UC-MSPH-546-19 | Environmental Physics | L-3, T-1, P-0 | 4 Credits |
|---|---|---|---|
| **Pre-requisite:** Knowledge of classical physics | | | |
| **Course Objectives:** The aim of the course in **Environmental Physics** to expose the students to of M Sc physics to the recent advancements in this field so that they understand these aspects properly and are well equipped to pursue a career in environment physics and other related fields. | | | |
| **Course Outcomes:** At the end of the course, the student will be able to | | | |
| **CO1** | Understand the different types of pollution that occur in the Earth's environment | | |
| **CO2** | Apply the laws of radiation to Solar and Terrestrial Radiation | | |
| **CO3** | Describe the main reservoirs and exchanges in the global carbon cycle and explain the challenges involved in reducing CO2 emissions | | |
| **CO4** | Application in the Renewable sources of energy | | |
| **CO5** | Describe how pollution and climate are modelled on different scales, ranging from the local environment to the global Earth system. | | |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 |
| **CO2** | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| **CO4** | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 3 |
| **CO5** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

**Detailed syllabus:**

1. **Essentials of Environmental Physics**: Structure and thermodynamics of the atmosphere, Composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Lass of motion, hydrostatic equilibrium, General circulation of the topics, Elements of weather and climate of India.

2. **Solar and Terrestrial Radiation:** Physics of radiation, Interaction of light with matter, tayleigh and Mie scattering, Laws of radiation (Kirchoffs law, Planck's law, Beer's law, Wien's displacement law, etc.), Solar and terrestrial spectra, UV radiation, Ozone depletion problem, IR absorption energy balance of the earth atmosphere system.

3. **Environmental Pollution and degradation:** Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors governing air, Water and noise pollution, Air and water quality standards, Waste disposal, Heat island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition.

4. **Environmental Changes and remote sensing:** Energy sources and combustion processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, hydropower, fuel cells, nuclear energy, Forestry and bioenergy.

5. **Global and Regional Climate:** Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces, Reynolds number, Enhanced Greenhouse Effect, Energy balance-a Zero-dimensional Greenhouse model, Global climate models.

**Suggested Readings/Books :**

1. Egbert Boeker & Rienk Van Groundelle: Environmental Physics (John Wiley).
2. J. T Hougtion: The Physics of atmosphere (Cambrige University Press, 1977).
3. J Twidell and J Weir: Renewable energy Resources (Elbs, 1988).
4. Sol Wieder: An introduction t solar energy for scientists and Engineers (John Wiley, 1982)
5. R. N. Keshavamurthy and M. Shanker Rao: The Physics of Monsoons (Allied Publishers, 1992).
6. G.J. Haltiner and R.T. Williams: Numerical Weather Prediction (John Wiley, 1980).

| UC-MSPH-547-19 | Dissertation | L-0, T-12, P-0 | 12 Credits |
|---|---|---|---|

**Pre-requisite:** Knowledge of specific branch of physics

**Course Objectives:** The aim of the **M.Sc.** Research project work or Dissertation is to expose the students to preliminaries and methodology of research in Theoretical Physics and Experimental Physics. Students get the opportunity to participate in some ongoing research activity and development of a laboratory experiment.

**Course Outcomes:** At the end of the course, the student will be able to

| | |
|---|---|
| **CO1** | Explain the significance and value of problem in physics, both scientifically and in the wider community. |
| **CO2** | Design and carry out scientific experiments as well as accurately record the results of experiments. |
| **CO3** | Critically analyse and evaluate experimental strategies, and decide which is most appropriate for answering specific questions. |
| **CO4** | Research and communicate scientific knowledge in the context of a topic related to condensed matter physics/Nuclear/High Energy Physics, in oral, written and electronic formats to both scientists and the public at large. |
| **CO5** | Explore new areas of research in physics and allied fields of science and technology. |

**Mapping of course outcomes with the program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | 1 | 3 |
| **CO4** | 1 | 1 | - | 1 | | 2 | 2 | 2 | 2 | 3 | 1 | 3 |
| **CO5** | - | 2 | 2 | 1 | - | 1 | | 2 | 2 | | 2 | 2 |

**Guidelines for the Dissertation:**

The aim of project work in M.Sc. 4th semesters is to expose the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiments, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc.. Project work can be based upon Experimental Physics, Theoretical Physics, or Simulation (quantum based softwares, HPCC, etc.) in the thrust as well as non-thrust research areas of the Department.

A student opting for this course will be attached to one teacher of the Department before the end of the 3rd semester. A report about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Head of Department.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc. as per course guidelines.

**Annexure-IV**

# Personality Development

**UNIT I**
**Building up and enrichment of Vocabulary**
Learning Derivatives, Prefixes and Suffixes; Homonyms & Homophones; Pairs/Group of words; Synonyms & Antonyms; One word substitution; Foreign words & Phrases

**UNIT II**
**Application of Business Communication**

**(a) Speaking Module**

- Oral communication-Everyday Interactions, Group Discussions, Public speaking;
- Conversation Skills; Business Etiquette;
- Presentation Skills- combating stage fright, preparing power point presentations
- Non- Verbal Communication in Oral & Power Point Presentations; Telephonic Skills;
- Preparation for job interview- practice through mock interview

**(b) Effective Writing Mechanism**

- Descriptive and argumentative essays,
- Scientific & Technical Writing- writing abstracts & summaries, research papers;
- Writing business letters, emails; memos;
- Drafting Reports- training reports, project reports, varied business reports;
- Career Documents: Preparing a selling resume, CVs, covering letters, Preparing Portfolio etc.

**Suggested Readings:**

1. Practical English Usage. Michael Swan. OUP. 1995.
2. On Writing Well. William Zinsser. Harper Resource Book. 2001
3. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
4. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
5. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
6. English Language Skills. Aruna Koneru. McGraw Hill Education (India) Private Limited. 2015.